Radio News

Vol. XI — CONTENTS FOR MARCH, 1930 — No. 9

In Radio News Next Month

Lieutenant William H. Wenstrom will link together such apparently unrelated things as radio, weather and spots on the sun. This interesting study, one of radio's latest developments, has great scientific possibilities.

TRAIL BLAZING THE AIRWAYS BY RADIO. *J. E. Smith* will tell how the Department of Commerce is establishing radio beacons along transcontinental air routes for the guidance of fliers through all sorts of weather conditions.

John B. Brennan, Jr., will describe a RADIO NEWS laboratory adaptation of a well-known manufactured battery-operated receiver for automobile use.

EXPLORING THE ULTRA-SHORT WAVES, by *A. Binneweg, Jr.* An article of helpful pointers and information regarding 5-meter receivers, for experimenters and short-wave enthusiasts.

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Photo © Underwood & Underwood

Senatore Guglielmo Marconi

MEN!

Get Your Copy of My *New* Book

It shows You

How to get a good job in the Radio Industry

Hundreds of Jobs paying $50, $60, $75, $100 a week are opening in Radio every year.

I showed these men how to get *Big Pay* jobs like *these*

If you are earning a penny less than $50 a week, send for my book of information on opportunities in Radio. It is free. Radio's amazing growth is making hundreds of fine jobs every year. My book shows you where these jobs are, what they pay, how I can train you at home in your spare time to be a Radio Expert.

Seldom under $100 a week

"My earnings in Radio are many times bigger than I ever expected they would be when I enrolled. In November I made $577, December $645, January $465. My earnings seldom fall under $100 a week. I merely mention this to give you some idea of what a Radio man can do who has the training."

E. E. Winborne,
1414 W. 48th St., Norfolk, Va.

$3000 a year in own business

"I cannot give N. R. I. too much credit for what I have been able to do in Radio. I can safely say that I averaged $3000 a year for the past three years. I am in the Radio business here. Any man who really wants to advance cannot go wrong in Radio. There is certainly a lack of trained men."

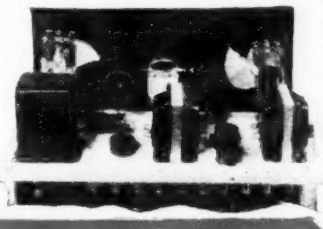
Fred A. Nichols,
P. O. Box 207, Eaton, Colo.

You have many jobs to choose from

Broadcasting stations use engineers, operators, station managers and pay $1,800 to $5,000 a year. Manufacturers continually need testers, inspectors, foremen, engineers, service men, buyers for jobs paying up to $15,000 a year. Shipping companies use hundreds of operators, give them world wide travel with practically no expense and $85 to $200 a month besides. Dealers and jobbers (there are over 35,000) are always on the lookout for good service men, salesmen, buyers, managers and pay $30 to $100 a week for good men. Talking Movies pay as much as $75 to $200 a week to men with Radio training. There are openings almost everywhere to have a spare time or full time Radio business of your own—to be your own boss. Radio offers many other opportunities. My book tells you about them. Be sure to get it at once.

My new 8 Outfits of Parts give you extensive practical Radio experience

With me you not only get the theory of Radio—you also get practical Radio experience while learning. You can build over 100 circuits—build and experiment with the circuits used in Atwater-Kent, Majestic, Crosley, Eveready, Stewart-Warner, Philco, and many other sets. These experiments include A. C. and screen grid sets, push pull amplification and other late features. When you finish my course you won't need to take "any old job" just to get experience—you will be trained and experienced ready to take your place along side men who have been in the field for years.



Back view of 5-tube screen grid tuned Radio frequency set—only one of many circuits you can build with the parts I give without extra charge.

I will train you at home in your spare time

Hold your job until you are ready for another. No need to leave home. All I ask is part of your spare time. I have doubled and tripled the salaries of hundreds through my practical home-study training. You don't have to be a high school or college graduate. My course is written in easy, simple terms that most anyone can understand.

Talking Movies, Wired Radio, Television Included

My course is up to date with Radio's latest uses and improvements. It includes Radio's application to Talking Movies, Television and home Television experiments, Wired Radio, Radio's use in Aviation, in addition to fitting you for many other lines. When you finish you won't be a "one job" man. You will be trained for many jobs.

Money back if not satisfied

I will agree in writing to refund every penny of your tuition if you are not satisfied with my Lesson Texts and Instruction Service when you have finished my course. This agreement is backed by the Pioneer and World's Largest organization devoted entirely to training men and young men for good jobs in the Radio industry by correspondence.

Find out what Radio offers you Get my Book

This book gives you the facts on Radio opportunities and the many features and service of N. R. I. training. It gives you 100 letters from actual students who have taken it to prove that my methods are successful. Get your copy today. There is no obligation.

J. E. Smith, Pres., National Radio Institute
Dept. OCSS, Washington, D. C.

THIS COUPON IS GOOD FOR ONE *FREE* COPY OF MY NEW BOOK — mail it NOW

J. E. Smith, President,
National Radio Institute, Dept. OCSS,
Washington, D. C.

Dear Mr. Smith:—Send me your book. I want to see what Radio offers and what you offer in Radio training. This request does not obligate me in any way.

Name.....

Address.....

City..... State.....

Lifetime Employment Service to all Graduates

The Broadcasting Goose

"ARE we killing the broadcasting goose, layer of many golden eggs?" Dr. Lee De Forest asked in his inaugural address, upon his election to the presidency of the Institute of Radio Engineers. Are we? The question has already aroused much controversy among radio broadcasters and in the newspapers. And RADIO NEWS urges its readers to consider—what is excessive radio advertising going to do to radio?

Advertisers were not slow to make the acquaintance of the broadcasting goose, and to appropriate their share of its golden eggs. A magazine or newspaper reader may deliberately let his eye slip over the "ads," if he is so inclined, but a radio "listener-in" is taken by surprise, and hears large amounts of gratuitous advertising, whether he wants to or not. In the earlier days of radio such announcements were usually of short duration, simple and concise. The listener understood, without any more ado, that a certain company had been presenting him with a program out of the kindness of its own heart. The listener was usually grateful, or at least did not cavil at this information.

But today advertising announcements over the radio have expanded to almost unbearable dimensions. The average layman, comfortably listening to an evening's program, is told at the end not only who the senders of that program are, and the name of the product which they manufacture, but also a thousand and one superfluous and—from his point of view—boring details.

The listener, however, has become canny. With the first sign of an overloaded advertising announcement he arises from his chair and crosses the room, grinning craftily, to turn the dial to another program. Or, if his radio is remote controlled, he can switch the program and grin craftily *without* rising from his chair.

In other words, the radio advertiser today is fast defeating his own purpose. He has become too greedy—too avaricious. He has lost sight of the principal object of broadcasting—the presentation of a program. He is on the way to becoming a megalomaniac. And he is demonstrating very poor psychology.

The broadcasters themselves, and a few advertisers, have mastered this psychology, as is evidenced by their programs in which a mere mention of the sponsorship is made. But the majority of advertisers follow one of two annoying methods—either the frequent breaking into a program with their announcements, or continual references to their own products woven into the program itself.

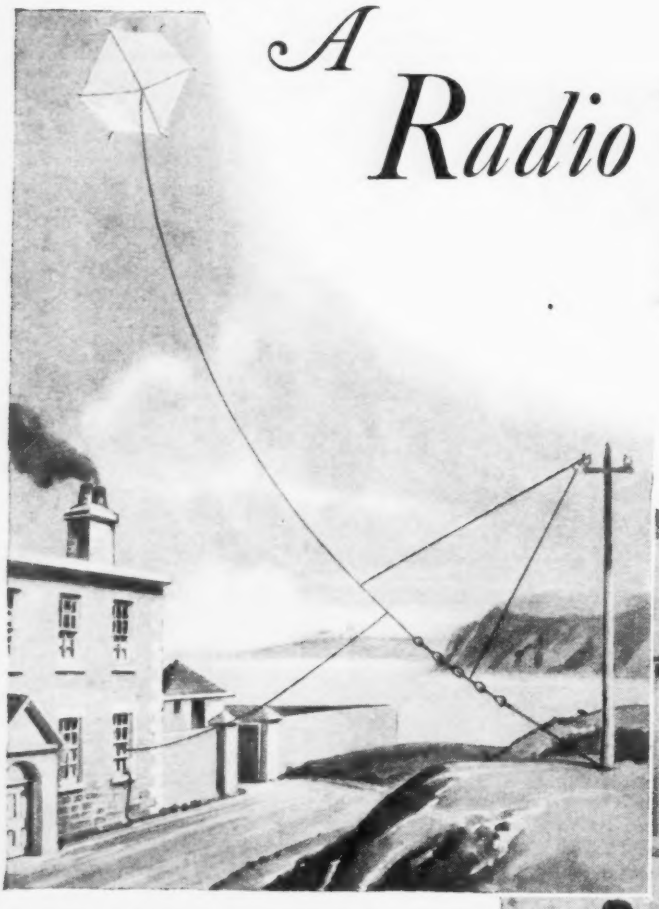
The general excellence of sponsored programs with their diversified presentations is undoubtedly responsible for the widespread acceptance of radio and its engineering development. But the whole thing is becoming too much like the old fairy story of the little girl who had to eat her way through a world of soup. It was very good soup, but there was too much of it. Our radio programs are presented by very good advertisers, but we have to hear too much about them. Direct advertising by broadcasters is ceasing to build good-will. Unless something is speedily done to remedy this situation, it is going to promote animosity and active dislike.

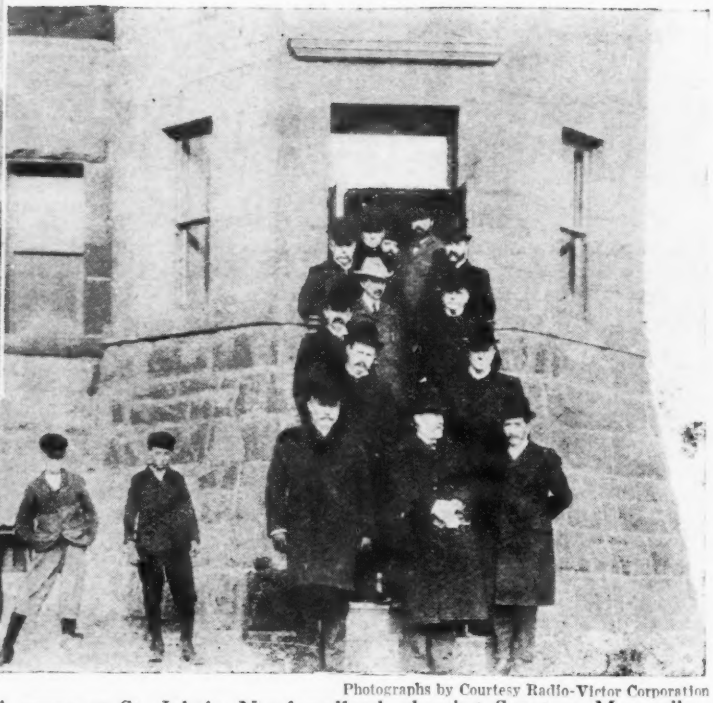
Where does the solution of this problem lie? Not with the listeners-in—they have already found their solution—turning the dial. Will it be necessary for the broadcasting stations to restrict and censor the advertising given them? That would be unfortunate indeed, and should not be the case. No—in our opinion the solution lies with the advertisers themselves. It is time for them to summon their good sense and to make a careful survey of the ground on which they stand. If radio advertising is to regain a position of value for both the advertisers and listeners-in, it must be censored by the advertiser himself! He must learn the psychological value and increased effectiveness of short and simple announcements. He must realize that he cannot pamper and overstuff his pretty goose, or there will be no more golden eggs.

Stuart O'Mahanay

A Radio DREAM

By





Photographs by Courtesy Radio-Victor Corporation

(Upper left) A scene at St. John's, Newfoundland, showing Senatore Marconi's arrangement for using a kite to support the antenna which he used in his first experiments. (Left) The kite itself. (Above) A group of engineers at St. John's who witnessed the first tests.

Following is Senatore Marconi's address delivered from the London studios of the British Broadcasting Corporation and rebroadcast in the United States by the National Broadcasting Company.

THE EDITORS

IT gives me very great pleasure to recount to Americans through the courtesy of the National Broadcasting Company of America and the British Broadcasting Corporation my experiences at the time when I first attempted and, indeed, successfully, to send radio signals across the Atlantic Ocean twenty-eight years ago, almost to the very hour.

From the time of my earliest experiments I had always held the belief, almost amounting to an intuition, that radio signals would some day be regularly sent across the greatest distances on earth, and I felt convinced that trans-Atlantic radio telegraphy would be feasible.

Very naturally I realized that my first endeavor must be directed to prove that an electric wave could be sent right across the Atlantic and detected on the other side.

What was at that time a most powerful wireless station was built at Poldhu in England for this purpose and an antenna system was constructed, supported by a ring of twenty masts, each about two hundred feet high. In the design and construction of the Poldhu station I was assisted by Sir Ambrose Fleming, Mr. R. N. Vyvyan and Mr. W. S. Entwisle.

Another similar station was erected at Cape Cod in Massachusetts. By the end of August, 1901, the erection of the masts was nearly completed when a terrific gale swept the English coasts, with the result that the masts were blown down and the whole construction wrecked. I was naturally extremely disappointed at this unforeseen accident, and for some days had visions of my test having to be postponed for several months or longer, but eventually decided that it might be possible to make a preliminary trial with a simpler aerial attached to a stay stretched between two masts 170 feet high and consisting of sixty almost vertical wires. By the time this aerial was erected another unfortunate accident, also caused by a gale, occurred in America, destroying the antenna system of the Cape Cod station.

I then decided, notwithstanding this further setback, to carry out experiments to Newfoundland with an aerial supported by

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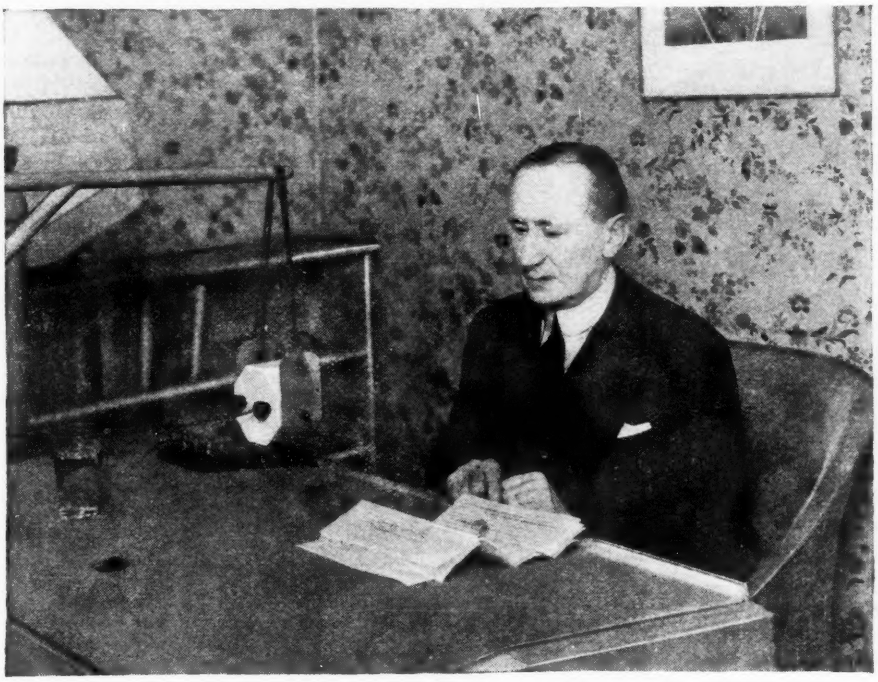
ON December 12, 1929, Senatore Guglielmo Marconi, who sent the first wireless message across the Atlantic twenty-eight years ago, spoke into a microphone in London and his voice was heard throughout the United States. Graham McNamee, in New York, introduced Marconi to American listeners.

Engineers of the National Broadcasting Company and the Radio Corporation of America were successful in picking up a short-wave broadcast from Station G-5SW, at Chelms-

COME TRUE

Senatore Guglielmo Marconi

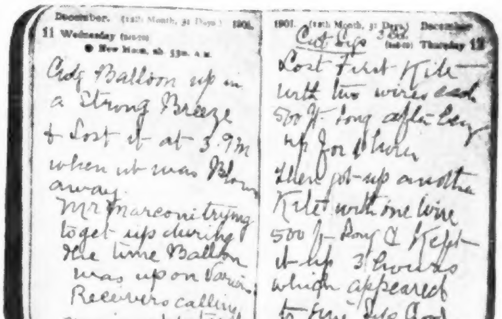


Senatore Marconi broadcasting from the English broadcasting station G-5SW at Chelmsford

International program on short waves from England celebrates the twenty-eighth anniversary of the first successful trans-oceanic tests

a balloon or kite, as it was clearly impossible at that time of the year, owing to the wintry conditions and the shortness of the time at our disposal, to erect high masts to support the receiving aerial. On the twenty-sixth of November, 1900, I sailed from Liverpool accompanied by my two technical assistants, Mr. G. S. Kemp and Mr. P. W. Paget.

We landed at St. Johns, Newfoundland, on Friday, December the sixth, and before beginning operations I visited the Governor, Sir Cavendish Boyle, and the Prime Minister, Sir Robert Bond, and other members of the Newfoundland government, who promised me their heartiest co-operation in order to facilitate my work. After taking a look round at the various sites, I considered that the best one was to be found on Signal Hill, a lofty eminence overlooking the harbor. On the top of this hill was a small plateau which I thought suitable for flying either balloons or kites. On a crag of this plateau rose the Cabot Memorial Tower and close to (*Continued on page* 849)



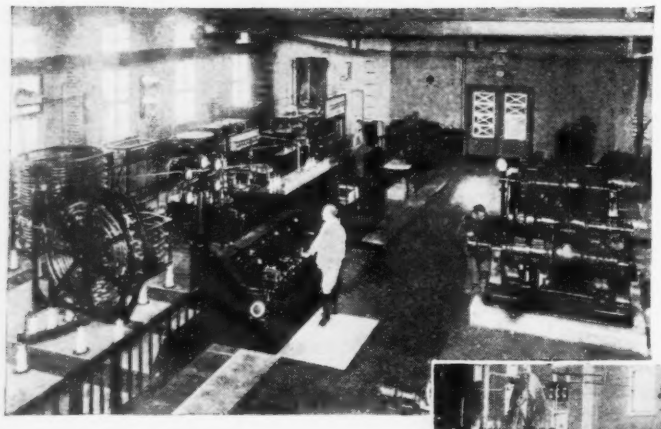
(Right) Photo of Marconi's log-book

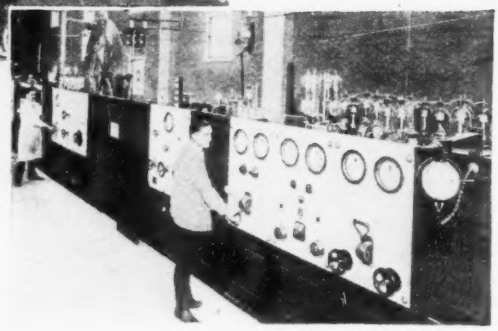
ford, England, of Marconi's voice, and it was rebroadcast through a chain of forty-six stations extending as far west as Denver. The short-wave signals were picked up at Riverhead, Long Island, and then routed to the New York NBC studios and the network. The rebroadcast was the sixth successful attempt of this organization to rebroadcast a program from abroad. WEAF and WJZ were the New York outlets.

(Left) Marconi and his two assistants, Mr. G. S. Kemp and Mr. P. W. Paget

Current

By Stuart





Above, the generators and transmitting equipment of broadcasting station at Königswunsterhausen, Germany, from which programs were transmitted on short waves to the United States on Christmas Day. Right, control room of the Königswunsterhausen station

David Sarnoff

ON January 3, 1930, David Sarnoff was elected president of the Radio Corporation of America, one of the highest honors conferable in the radio world. His career, from his very entrance into industrial life, has run parallel with the vast expansion of radio communications throughout the world. Still a young man—barely thirty-nine years of age—he has directed, as general manager of the R. C. A., the operating activities of the first American owned and operated system of wireless communication. Later, as vice-president and subsequently as executive vice-president of the company, he helped to organize and shape a great developmental program in electrical communications that brought the radio industry to the forefront of industrial achievement.

Born in Southern Russia, Mr. Sarnoff came to America as an immigrant with his parents when he was only a child. When he was fifteen he secured a position as an office boy with the Marconi Wireless Telegraph Company of America. This was the beginning of his meteoric rise to eminence in the radio field. He became commercial department manager of the Marconi company and, in 1919, general manager of the R. C. A.

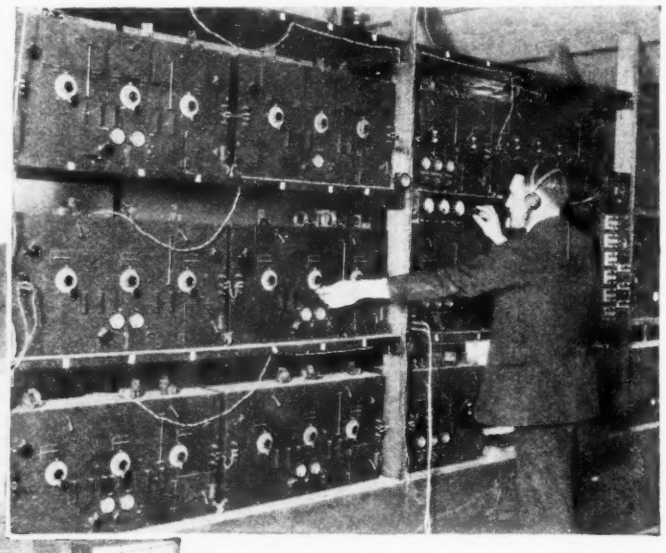
With the first faint rise of the broadcasting art in the United States, Sarnoff saw the opportunity for the development of a new service and a new industry. His pioneer experience in the art aided in the program of industrial and patent mobilization that made it possible for the United States to assume an immediate and leading position, not only in international wireless communications, but in the new industry that broadcasting had brought into being.

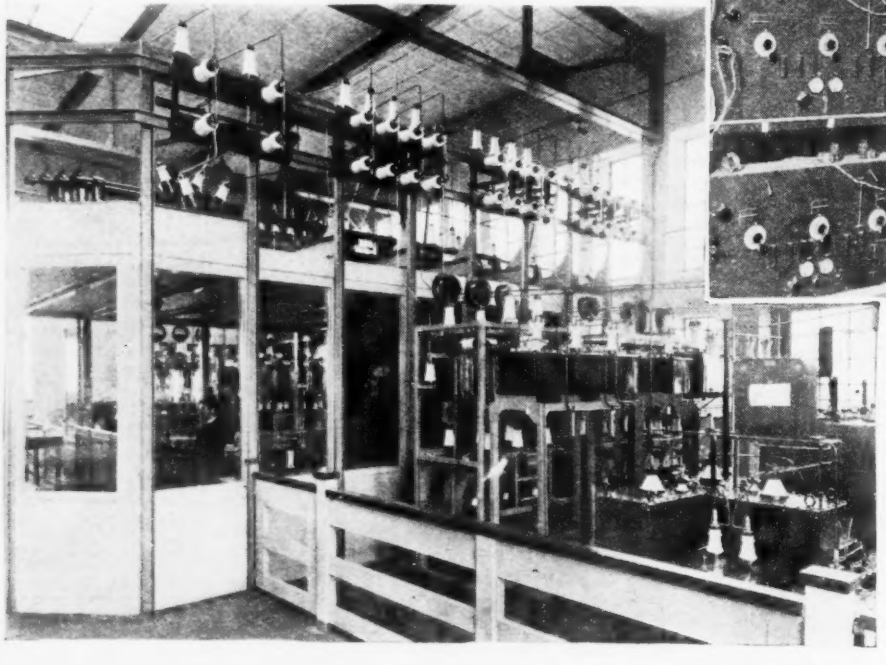
He was a leading figure in the organization of a permanent broadcasting service, improved broadcasting programs, and the acquirement of more talent and national coverage. In 1928 David Sarnoff became president of RCA Photophone, Inc. His negotiations later resulted in the formation of the Radio-Victor Corporation and the General Motors Radio Corporation.

His contributions to radio have been tremendous. He has been a vital and significant factor in the molding of the radio world in its present form, and, considering his past achievements, R. C. A. may consider itself fortunate indeed to have such a man as David Sarnoff at its head.

Overseas Broadcasting

The first international exchange of broadcast programs on





Above, short-wave receivers at Riverhead, L. I., used by the National Broadcasting Company for receiving transoceanic programs. Left, control room and transmitter equipment of PCJ, Huizen, Holland, which broadcast programs received in this country on Christmas Day

Comment

C. Mahanay

Christmas day was an exceedingly successful achievement and a triumph of radio engineering. Reception in this country, from Eindhoven, Holland; Königswunsterhausen, Germany, and London was remarkably clear. Reports from the Continent have indicated that our program was also satisfactorily received.

This overseas program has introduced two questions. First, in what respects was our own broadcast inferior to the European one? The music received from the other side was all of an excellent quality, well-presented and interesting to hear, Our program consisted, for the most part, merely of saxophone brayings and other typical evidences of our night-club hilarity. We did not repay Europe in the same coin. On such an occasion it should be our natural desire to present only the best—and our best is a good best, if we care to present it. It is to be hoped that next Christmas we will give Europe a program worthy in all respects of its own.

The second question which arises is one which is always summoned at such times: What is across-the-seas broadcasting going to do for a universal language? Will it help to bring it about? Undoubtedly it points the way to what is a daily more urgent need. But the probability is that not for many more years will feeling be strong enough to bring any sort of action on this matter.

A Radio Bonfire

Witnessed by city officials, a squadron of police and members of the fire department, the biggest burning of obsolete radios in the history of the industry was held near City Hall, in Philadelphia, under the auspices of Philco's local dealers, recently.

One thousand radio receivers, adjudged obsolete, went up in flames, after scores of other sets had been saved for the hospitals and the poor of the city. J. C. Marden arranged the big bonfire, with the idea of boosting business in new sets. Also, he said, sale of more new sets would be in keeping with the Hoover prosperity plea.

A representative of the Mayor's office presided at the bonfire, which attracted thousands of spectators during the afternoon of the spectacle, held four blocks from the Municipal Building.

As ninety per cent. of a radio receiving set is metal, a large quantity of parts which remained after the fire was sold for junk and the money realized in this manner was turned over to the Philadelphia Christmas Seal Relief Fund.

A Successful Receiver

Among the men who have been outstandingly successful in the radio industry is E. H. Scott, designer of a superheterodyne receiver which is sold exclusively, through authorized and qualified representatives, in cities throughout the country. At a time when many manufacturers are in the throes of serious financial difficulties, Mr. Scott greatly increased his manufacturing facilities, in order to supply the demand for his custom-built product.

This superheterodyne is the realization of a dream which the designer believed might some day come about—a laboratory creation in every sense of the word. The Scott method of distriblution has proved a success, as is evidenced by the phenomenal sales record of these receivers.

Auto-Radio

The one-time phantom of auto-radio is rapidly materializing. Predictions by leaders in the industry indicate that radio sets will eventually be sold largely by automobile dealers. Several prominent motor companies have already distributed radio sets through their dealers, and radio producers are making arrangements with individual dealers for distribution.

David Sarnoff, President of the Radio Corporation of America

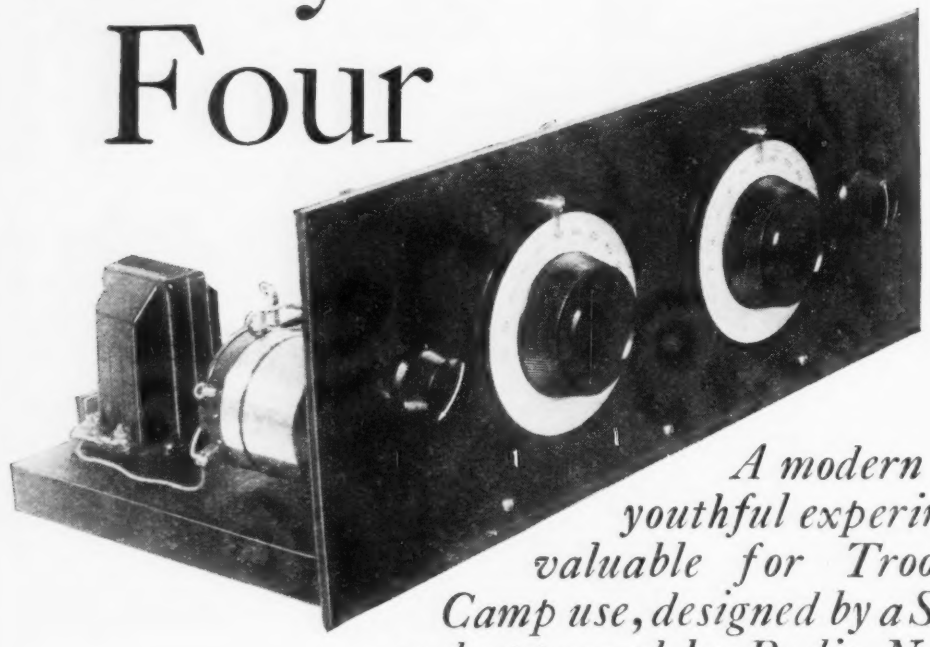
One of the big difficulties of the radio manufacturers has been that of securing proper representation in the smaller communities. Few of the stores found in the average village or small town can afford to keep a complete line of sets in stock, and the advertising devoted to them is, of necessity, limited. The automobile dealer, however, is accustomed to going out and selling his product, and is trained to recognize the necessity of servicing the commodity he sells. It seems, therefore, only natural that a large part of the future of radio sales should rest with him.

The handling of radio receivers will enable automobile dealers to pass more comfortably through the winter months—always a difficult period for car sales, and an excellent one for radio.

On the other side of the Atlantic the fame of auto-radio is also growing. A Paris taxi-driver reports that, since he has equipped his cab with radio, he is able to persuade even the most impatient riders to remain calm and contented in traffic jams, and that by tuning in love songs amorous couples can be easily enticed into taking rides.

Philco dealers make a bonfire of obsolete radio receivers

The "Boy-Scout" Four



By John B. Brennan, Jr.
Scoutmaster, Troop 3, Hollis, N.Y.

A modern receiver, suitable for youthful experimenters and especially valuable for Troop Headquarters or Camp use, designed by a Scoutmaster for Scouts, and approved by Radio News Technical Staff.

ALL boys, whether they be Boy Scouts or not, have at some time or other felt the urge to build a radio receiver which they could call their own, a receiver which they could proudly say they built "from the ground up."

Boy Scouts are particularly interested in this phase of radio, because some of the tests which must be passed for advancing in Scouting from one rank to another require a working knowledge of radio.

The Radio News Boy Scout receiver has been designed for just such boys.

All through the process of designing and constructing this receiver a number of important considerations have been kept in mind. They are, first, that the receiver must be of simple design, and not difficult to understand as far as construction is concerned. Secondly, it must be low in cost, necessarily using parts which are easily obtainable at not too high a price. However, naturalness of tone should not be sacrificed to mere cheapness. As an indication that the parts finally employed are easily obtainable at a reasonable cost, those parts selected are, in almost every case, to be found on sale in chain stores such as Kresge's, McCrory's, F. W. Grand and W. T. Grant. Third, it must be so designed as to be easily wired, for nothing so discourages a set-builder as to be confronted with a complicated circuit, often resulting in a maze of wiring which even the experienced would find difficult to check. Fourth, the receiver must be one which can be operated easily. The number of controls had to be cut to a minimum, and actual tuning operations had to be accurate so that station positions on the dials could be logged.

The Circuit

After considering all these qualifications which the final set must possess it was decided to employ a simple four-tube circuit which, through all the years of progress and development in the radio art, still enjoys popularity.

It consists of one stage of tuned, neutralized radio-frequency amplification, a regenerative detector and two stages of transformer-

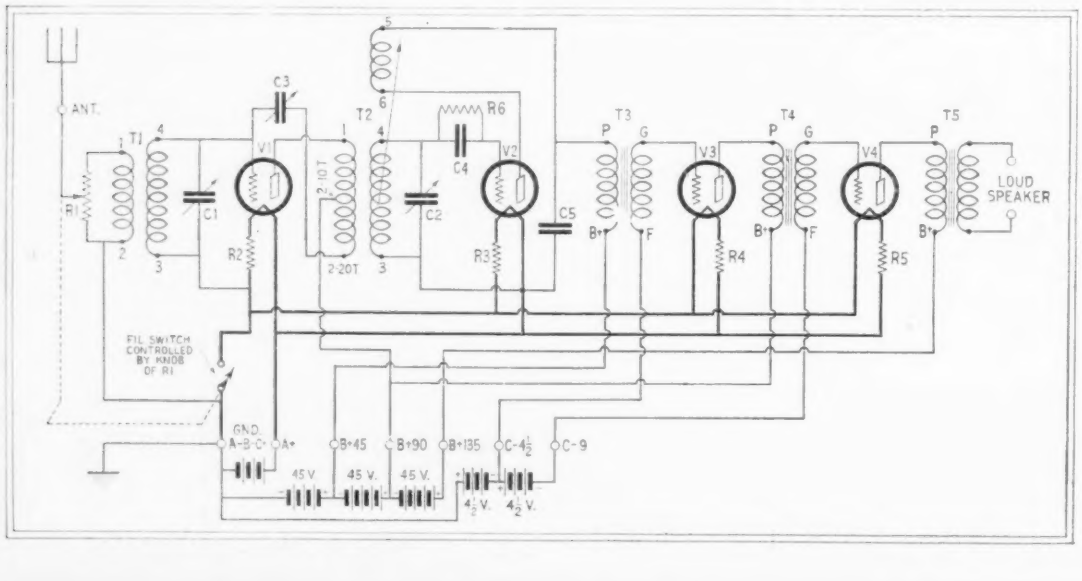


Fig. 1—An old "standby," a four-tube circuit, is employed in the "Boy Scout" receiver. One stage of tuned neutralized radio-frequency amplification is followed by a regenerative detector and two stages of transformer-coupled audio-frequency amplification

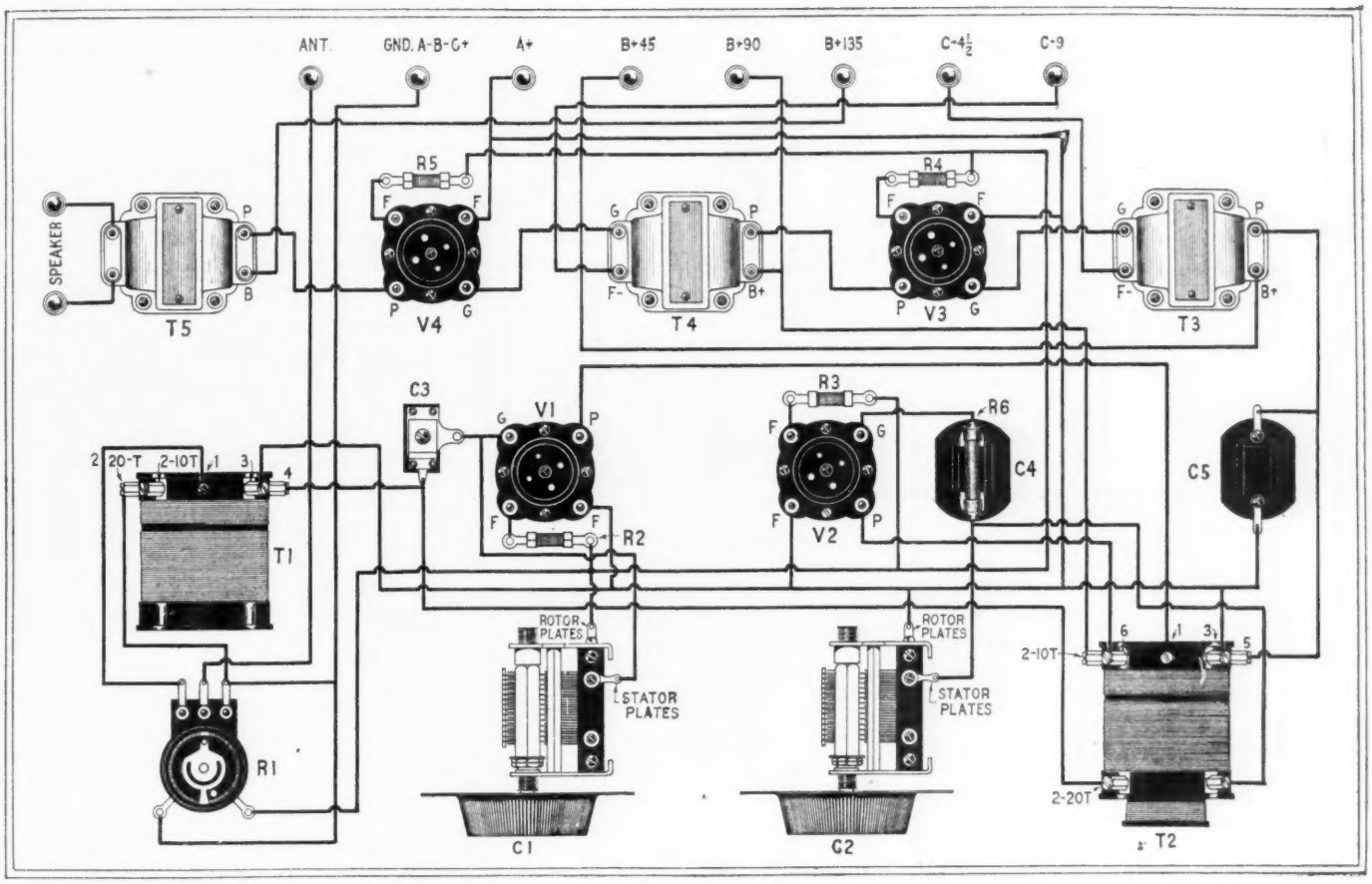
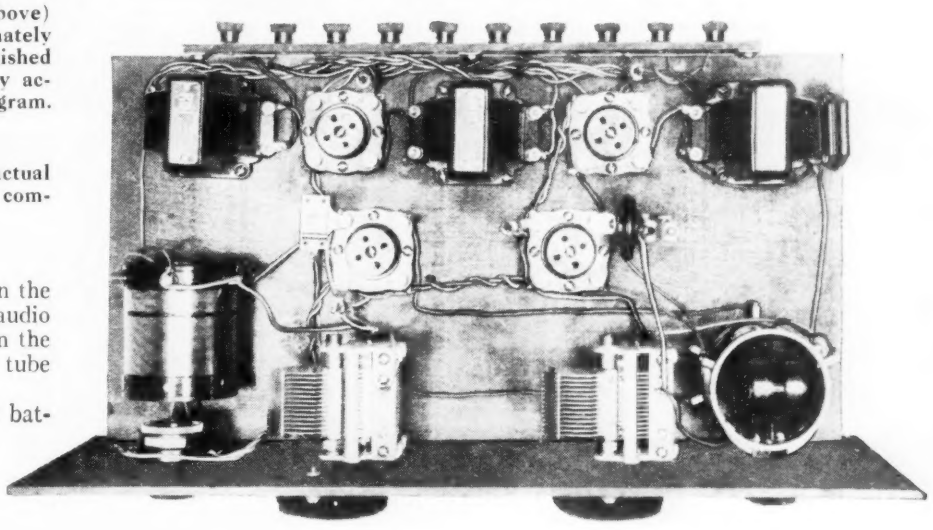


Fig. 2—In the picture wiring diagram (above) each of the parts is shown in approximately the same position it occupies in the finished receiver. Wiring of the receiver is easily accomplished with the aid of such a diagram.



This top view of the receiver shows the actual location of all the parts. It should be compared with Fig. 3

coupled audio-frequency amplification. In the radio-frequency, detector and first audio stages, type –01A tubes are employed. In the final or output audio stage a type –12A tube is used.

In this article the circuit is shown for battery operation, but in a forthcoming issue instructions for building a power supply, to be operated from the light socket, will be given.

Now, taking up each part of the receiver circuit, the radio-frequency amplifier is used to build up the feeble signals which are absorbed by the antenna system. However, certain precautions must be taken to make this radio-frequency amplifier stable in operation, for it has a habit of going into oscillation and acting as a miniature transmitter of squeals and squawks. To prevent this amplifier from oscillating, a neutralizing system is employed. If you will look at the circuit diagram of the receiver, Fig. 1, you will see that the plate coil connected to the plate of the first tube is tapped at the center, and connection to the "B" batteries made at this point instead of at the lower end of the coil, as is usual. Note, too, that the lower end of the coil connects through a small variable condenser to the grid of the same tube.

Now, if the r.f. tube oscillates, any voltage which is set up in the upper half of the plate coil is also set up in the lower half. The voltage in this lower half of the coil is equal to that in the upper half, and, by means of the equalizing condenser, is applied to the grid of the tube in opposite phase or relation to that existing on the plate. In this way, since the two effects set up are equal and opposite, they cancel each other and thus prevent the circuit from oscillating.

This system of oscillation control is known as the Roberts scheme of neutralization, and has been employed with great success in such popular circuits as the Roberts Reflex receiver, the General Radio Universal Receiver, the Aristocrat and others.

The detector circuit is of the regenerative type and employs a tickler coil for regeneration. This is called the inductively coupled feedback system. Although a type –01A tube is specified for this part of the circuit, it is equally possible to employ the 200A tube, a special detector tube. In the –01A, the return connection from the lower side of the secondary of the detector coil is made to the minus side of the filament supply, whereas with the 200A tube the connection is made to the positive side of the filament supply.

Two transformers of 3½ to 1 ratio are employed in a standard transformer-coupled audio-frequency amplifier. A coupling transformer is located in the circuit between the final audio tube and the loud speaker.

Construction

In designing a receiver it is usually the aim of the designer to arrange the parts so that, first, the various pieces of apparatus are arranged to provide short direct connection one to the other,

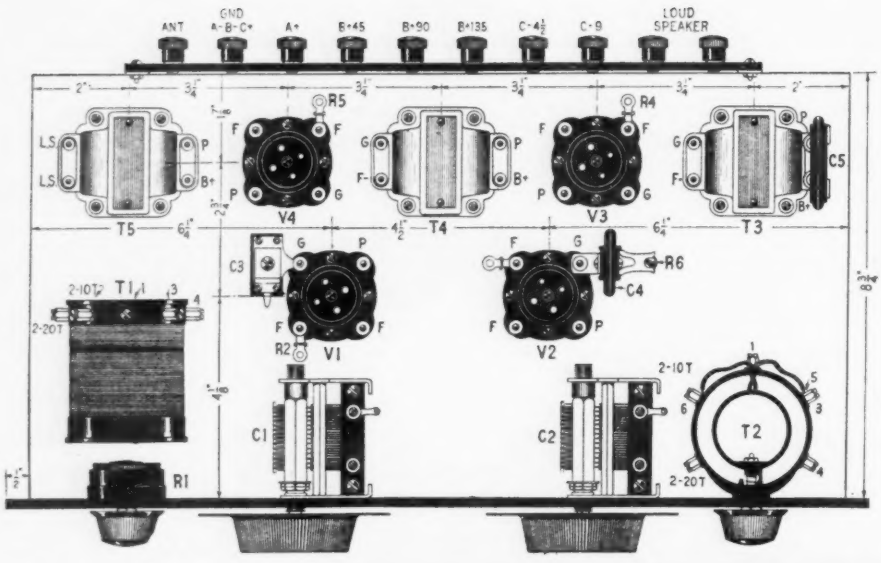
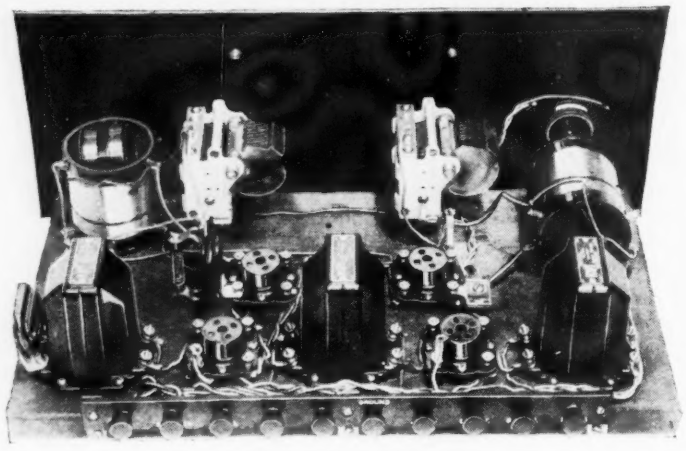


Fig. 3—The location of each part to be mounted on the baseboard is indicated here. Before permanently fastening the units in place, locate them temporarily and check with this layout



A behind-the-panel view of the Boy Scout Four

and secondly, the tuning and other control units are placed so that a symmetrical panel appearance is obtained.

It used to be the general practice to construct a receiver much in the same fashion as the circuit was drawn. That is, the r.f. and tuner elements took up the left end of the baseboard while the audio channel was strewn along the right end. This resulted in an unbalanced panel appearance. Now the practice is quite general to lay out the apparatus in the form of a U which has been dropped over on its left side, thus ⊃. On the lower side of the U is placed the r.f. and detector apparatus while the audio parts are situated along the upper side. Not only does this practice make for greater compactness and cleaner panel appearance, but it also materially shortens the connecting leads.

Assembly

The first thing to do is to obtain the parts as listed in the parts list. Since the receiver has been actually built with these parts, and the layout made accordingly, it is recommended that no substitution be made unless the substituted parts are somewhat like those recommended.

After all the parts have been purchased, the 7 by 18 panel should be drilled according to the drilling layout shown in Fig. 4. It is well to make the hole first with a small drill, say a No. 28, and then, where necessary, enlarge with a bigger drill to the proper size.

When all the holes have been drilled, the two tuning condensers, the volume control and the detector coil may be mounted in their proper places on the back of the panel.

Then, following carefully the layout of the baseboard parts, as shown in the accompanying photographs and in Fig. 3, the sockets, transformers, etc., should be placed in position. Once you have decided that these parts are in their right places they should not be moved, but fastened securely to the baseboard with round-head brass woodscrews.

The binding post strip is held to the rear edge of the baseboard by three round-head brass woodscrews. When all the baseboard parts have been mounted, the panel is fastened to the front edge of the base.

Wiring

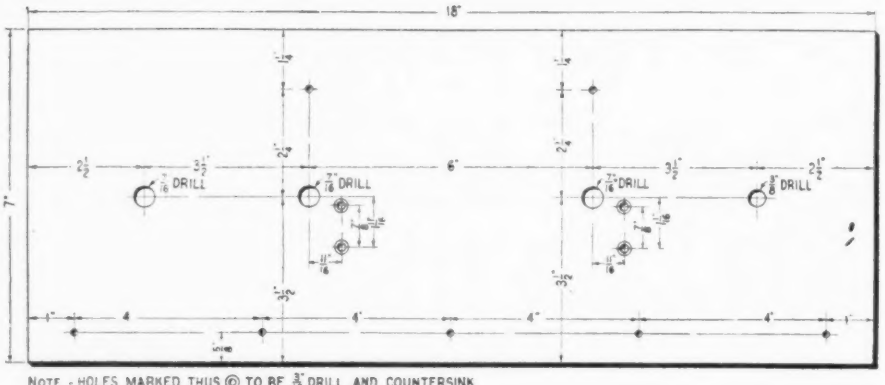
The wiring of the receiver is most easily accomplished with the aid of a soft, solid, well-insulated wire. This type of wire takes solder well and makes a clean, firm, soldered joint. All connections should be soldered to insure permanence of operation.

The picture wiring diagram shown in Fig. 2 will aid materially in making these connections. It is suggested that a regular procedure be adopted in wiring the set. First wire all the filament circuits, then all the grid circuits, then all the plate circuits.

Operation

Before the receiver can be operated satisfactorily it will be necessary to provide a good antenna and ground system. If the set is to be used in your Troop Headquarters, the antenna-ground system can be a permanent one. If the set is to be used in camp, then you will have to get along with the best antenna and ground which conditions will permit. Generally, the antenna should be about 75 feet long and fairly high, say 40 to 50 or more feet. In camp, an iron pipe driven into moist earth will provide a satisfactory ground.

Fig. 4—The panel of the receiver should be laid out and drilled for mounting holes, as shown in the layout below



Three 45-volt "B" batteries, two 4½-volt "C" batteries and one 6-volt storage battery are required to operate the set. The r.f., detector and first audio stages require –01A type tubes, while a –12A is used in the final audio stage.

Connection of the batteries to the binding post strip is shown in the diagram, Fig. 5.

When all these connections have been made, the tubes inserted in their sockets and the loud speaker, antenna and ground connected to their respective posts, the set is ready for final adjustment.

With the tuning controls set so as to receive a weak signal, turn up the regeneration control slightly so that a whistle or squeal is heard in the loud speaker. Now, if by turning the left-hand tuning dial (C1) an uneven squeal is produced, having two distinct but unequal peaks to the whistle, it is an indication that the neutralization of the r.f. stage is not perfect and requires adjustment. This is done (*Continued on page* 872)

Solving a Broadcaster's Dilemma

Problems That Arise in Connection With Receiving Sets Are Really Insignificant in Comparison With Those of Broadcast Station Operation

By C. S. Gleason

THE great majority of listeners have little occasion to learn about the inside problems which arise in the efficient operation of a high-power broadcast station, and, providing no interruption occurs during the enjoyment of a favorite feature, they probably care even less.

But let a break occur, and their first move is to telephone the station to know "why." Some even are stirred to put their thoughts—or at least some of them—on paper in no uncertain terms, for the benefit of the station manager.

Mr. Gleason, the author, tells here the story of how one station, out on the west coast, after moving to improve its service, found that the local area was not being served as well as before the change. Simple though the trouble appeared to be, it required a good deal of time and labor to track it down.

Although not intended particularly for the guidance of station managers, this article will undoubtedly open up to them new lines of thought. At the same time, it will give to broadcast listeners some inkling of the tremendous problems which beset the station manager in his efforts to remain on the air "on schedule."

TROUBLE was brewing at KNX, and wise studio underlings, seeing the storm clouds gathering about the station manager's brow, were scurrying to cover. True, reports trickled in constantly from the forty-eight states of the Union, from Canada, Mexico, Cuba, and Alaska, with a fair sprinkling of acknowledgments from Australia, New Zealand, Japan, England, and various South Sea islands. But listeners in parts of the surrounding area, including the northeastern suburbs of Los Angeles, had reported that KNX was not coming in as well as before it had moved its transmitter from Hollywood to a point in San Fernando Valley, seven miles away, where it is operated by remote control from the studio on the Paramount Pictures' lot. And when things begin to happen to the local service area there is bound to be trouble. Broadcasters must fully cover the local area whether distant listeners are served or not; and it was the desire of the owners of KNX that their station blanket Southern California with a bumping signal amply strong to override static and atmospherics at all times of the year.

Technicians scratched their heads. The usual number of amperes were going into the antenna, and field strength tests showed 15,000 microvolts per meter at Santa Monica, 15 miles away. But up at Altadena, about 25 miles removed in a straight sweep up the valley, the intensity was somewhat less than the 10,000-microvolt level set up by engineers as a standard for "excellent, year-round loudspeaker reception." And when Naylor Rogers, station manager, called his technicians into his office and in a few well-chosen words delivered an ultimatum to the effect that something was wrong and that the technical honor of the station depended upon their finding out what it was, things began to move rapidly.

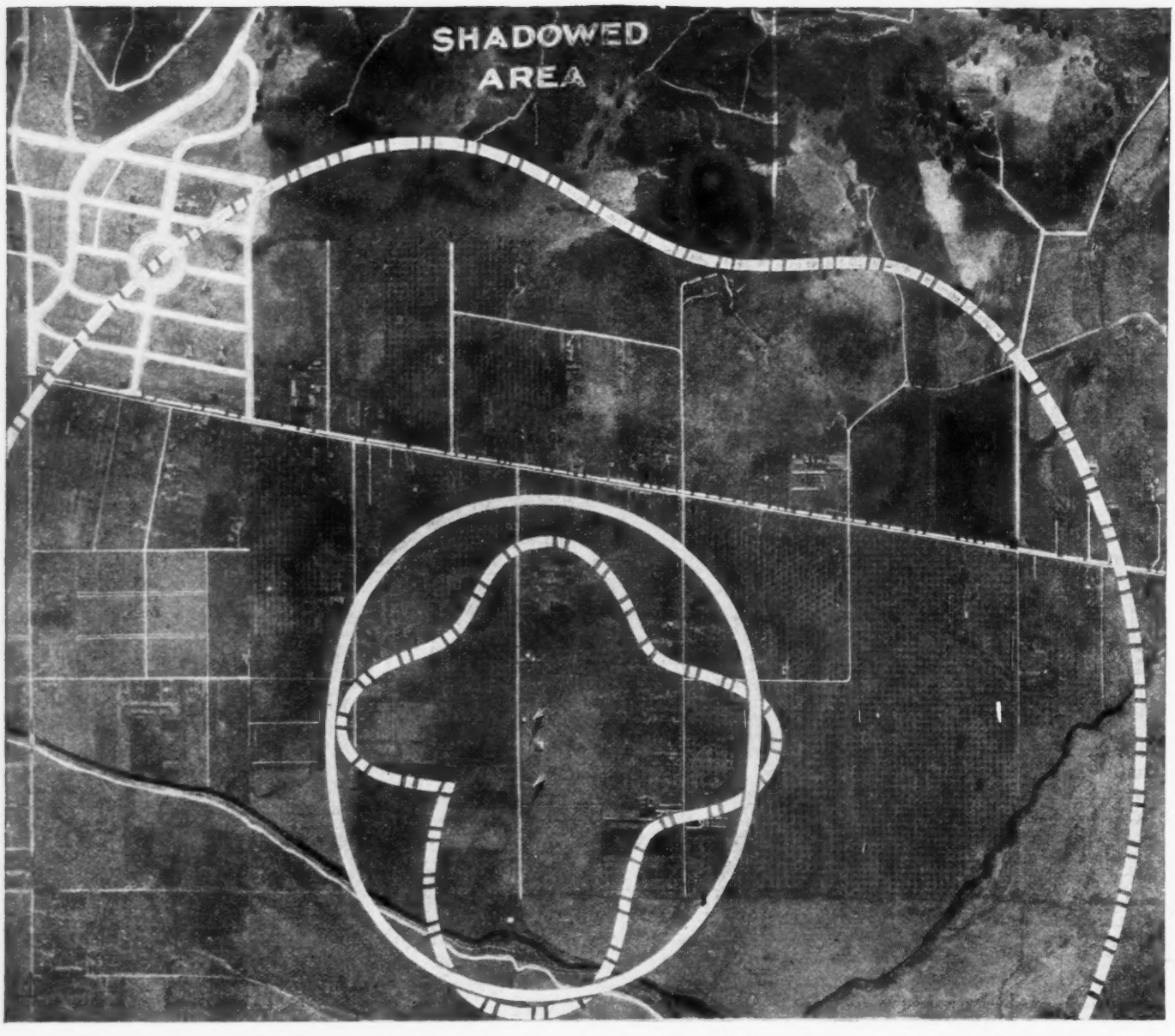
Within a short time Ole M. Hovgaard, a survey engineer of the Bell Telephone Laboratories, was summoned. Earle C. Anthony, Packard distributor and owner of KFI, heard of what KNX was doing, and generously tendered the use of a seven-passenger Packard straight-eight phaeton. Into this vehicle was loaded all the apparatus necessary to determine the way a station's wave was behaving after being shot out from the antenna into space.

Upon a geological survey map showing the contours of the surrounding district, a circle was traced around the station's location, with a radius such that the circumference followed, as closely as possible, existing boulevards. This represented the ideal field distribution. Then, with the transmitter at KNX running at fixed output, a point on the circumference of this circle was selected. Here a special shielded superheterodyne was tuned to KNX's wave and the reading of a milliammeter placed in the plate circuit of the second detector was noted. Then a local oscillator was substituted as the source of current, and the intensity of its output adjusted until the milliammeter reading was the same as before. The oscillator output thus measured KNX's field strength. At various points within the circle other readings were taken.

By the time the circuit was completed and the readings plotted upon the map, with the points of equal field strength connected by a smooth line, the resultant figure was far different from the perfect circle of ideal distribution. The general trend of the loops and kinks was roughly toward a figure-eight, with several minor bulges giving a clover-leaf effect. Evidently the radiation was most effective in a line running approximately crosswise to the valley and down to the ocean. But over a sector N. 130° E., and over most of Hollywood and Beverly Hills, the radiation was weaker—about 67% of that to the east and south, in which direction lay the Santa Monica Mountains, a long, low range running north-northeasterly down to the ocean, and attaining a height, at some points, of approximately 1,400 feet.

Mr. Hovgaard knew that mountains, as well as skyscrapers and city areas, have a pronounced screening effect. This effect he set about to measure. Over the few existing roads through these mountains—many of them hardly more than trails, rough and crevassed by the rains—went the field car. Measurements were taken at points on an ever-widening spiral, terminating at last beyond the mountains. And when the results were plotted upon the map, it was found that on the far side of the mountains the signal strength dropped sharply, the shadow effect in places reaching as high as 60%. The outlook for improving reception was not bright, since it was not considered practicable to change the physical features of the topography so as to straighten out the clover-leaf into a nice, symmetrical circle. Boundless as was Mr. Rogers' faith in the ability of the Bell engineers, it was not sufficient to move these mountains.

But Mr. Hovgaard did not believe that this told the whole story. The intensity on the side away from the mountains was also low. Why should there be a shadow



The country surrounding KNX's transmitter mapped by a Fairchild ship. The clover-leaf outline indicates the field before new insulators were installed. The oval shows the result of the change which redistributed the field to the nearly perfect circle of theory. The largest curve illustrates the effect of the Santa Monica Mountains upon the station's radiation

where there was nothing to cast one? So he set out on another series of tests. The frequency was lowered to 700 k.c., and a new curve was plotted.

"Aha!" exclaimed Mr. Hovgaard. "The plot thickens!"

The distribution of the field, while not perfectly uniform, was at least ovular in shape. And the reason, deduced Mr. Hovgaard, was what he termed "tower resonance."

Now the antenna at KNX, as will be seen from the photo, is a single vertical, six-wire cage 179 feet long, swung between two graceful steel towers 225 feet high and 550 feet apart. It so happened that the natural period of the tall slim masts coincided very closely with the frequency assignment of KNX: namely, 1,050 k.c. The towers therefore acted as resonant circuits, and a large current was easily induced in them by the passing wave, with the result that the field was greatly distorted in that direction.

In his report, Mr. Hovgaard summed up the situation briefly as follows—that the trouble was due to four causes:

(1) Directive and inefficient performance due to tower resonance.

(2) High attenuation by the Santa Monica Mountains.

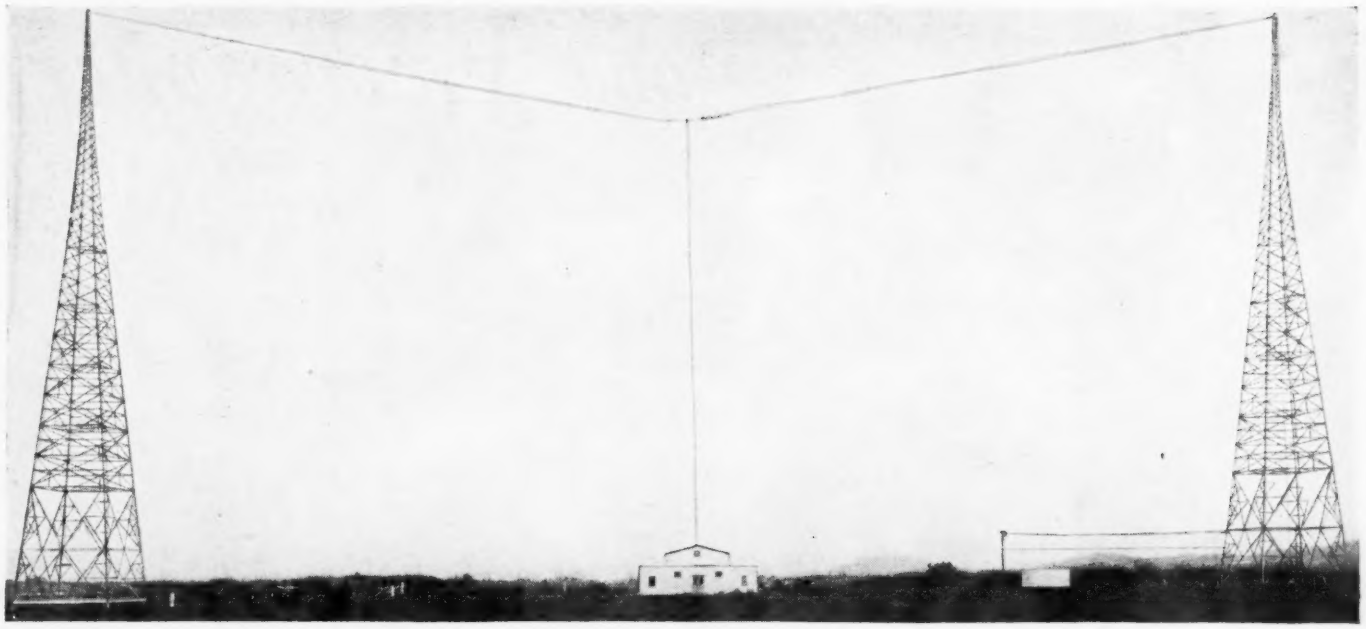
(3) The relatively highly carrier frequency.

(4) The relatively great distance of the station from the local areas to be served.

Although it is true, he said, that greater distance of transmission had been obtained more easily on the shorter waves, it is also true that for local service, which depends upon the "ground wave," the lower frequencies are attenuated less with distance and so can serve larger areas dependably. Given equally powerful stations and equally efficient antenna systems, the signals at fifteen miles' distance from a station on 1,050 k.c. will be 15% lower than from a transmitter on 700 k.c. At greater distances, this effect is even more pronounced. The intensity of the ground wave falls off rapidly with distance: for example, on 1,050 k.c. it will take only one kilowatt of power to produce the same signal as will be heard at 15 miles with five kilowatts output. The one-kilowatt signal at three miles is four times as strong as that from a five-kilowatt station at fifteen miles. Therefore it is a good thing to get as close to the area to be served as possible, bearing in mind, however, that too close proximity to business districts may result in high attenuation and "shadows" cast by tall, steel-frame buildings.

"Well, what are the remedies?" Mr. Rogers wanted to know.

"There are a number of possible solutions," replied Mr. Hovgaard. "First, you can move closer to the city. That is expensive. Second, you can increase your power, provided the Radio Commission will let you. That is cheaper and has the advantage that at the same time your distant service range is increased. Third, you can change your carrier frequency—with the consent of the Commission, of course—from 1,050 k.c. to 720 k.c. or less. This will avoid resonance with the towers, and will improve the field strength in the more important areas by about 100%—an audio frequency improvement of about twelve decibels.



The towers of Station KNX after insulators have been installed in order to minimize their absorption effects

Fourth, you can erect a new and larger antenna, with two 350-foot steel towers 700 feet apart and mounted on insulated footings, which will break up the electrical circuit of the masts and prevent resonance with the carrier. If you do this, you may expect an improvement of 180% in the Beverly Hills region and about 40% in other directions. Or you can reduce the height of your present towers, in order to reduce their natural period until it no longer approaches your transmitting wavelength. By lowering the towers to 150 feet the resonant frequency would be shifted to about 1,500 kilocycles.

Sixth, you can doctor up the masts and change their resonant frequency by loading them electrically with inductances; this is not a sure cure nor entirely effective. A multiple-tuned antenna would get around the difficulty, but it would be expensive for the amount of improvement it would give. Lasty, you can insulate the footings of the present antenna by installing insulators, thus breaking up the electrical circuit. This would give you an improvement of 50% in Hollywood and Beverly Hills—an audio gain of seven decibels."

"Well," said Mr. Rogers, "we know we don't want to move. We have had trouble enough finding our present location without breaking up housekeeping and moving again. Even if we should increase power, we would still be resonating with the towers. We want to make the most of the wave we radiate. To get a new frequency assignment would at least take time, if it were possible. We don't want to wait, nor do we want to rebuild our antenna if it can be fixed up as it is. It would be too bad to spoil our beautiful towers by cutting them off at the top. Your sixth and seventh solutions you yourself do not regard as very satisfactory. What about insulating the present masts?"

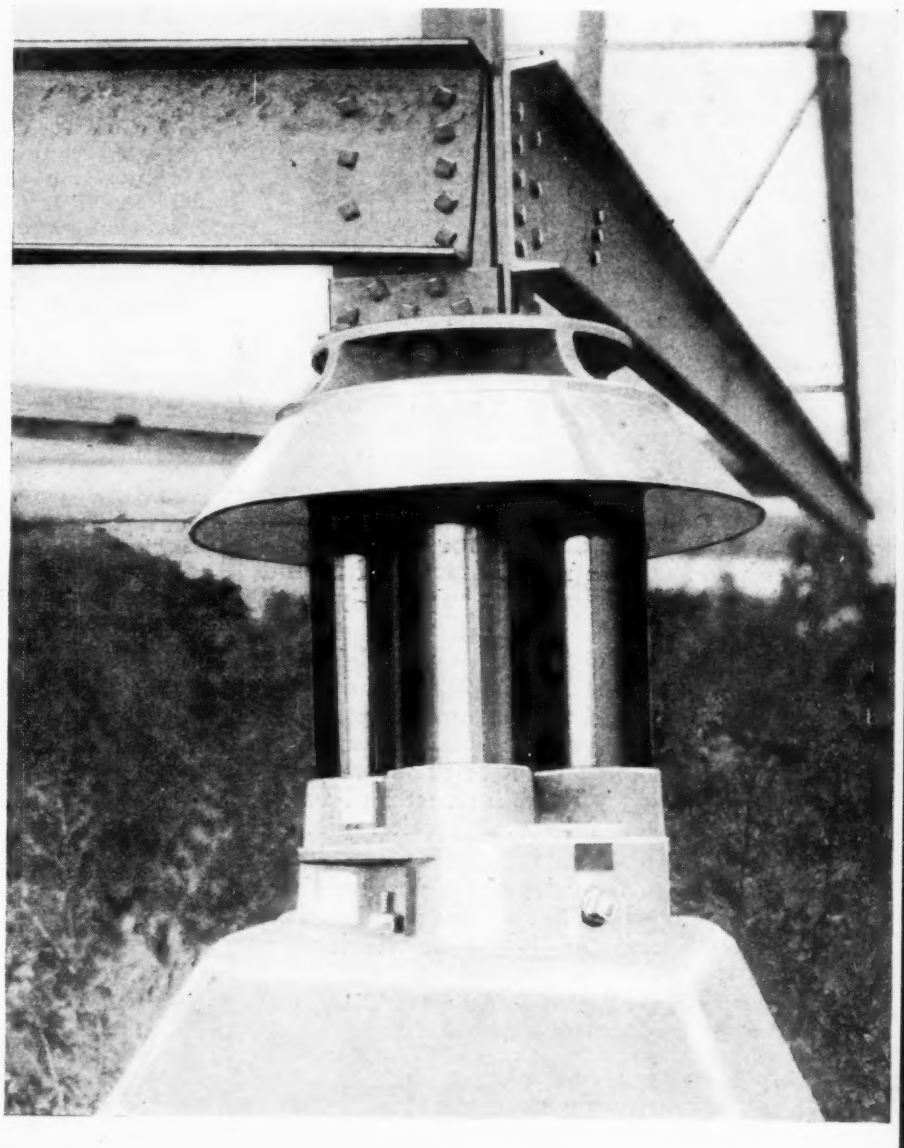
"It can be done," replied Mr. Hovgaard.

"Do it," said Mr. Rogers.

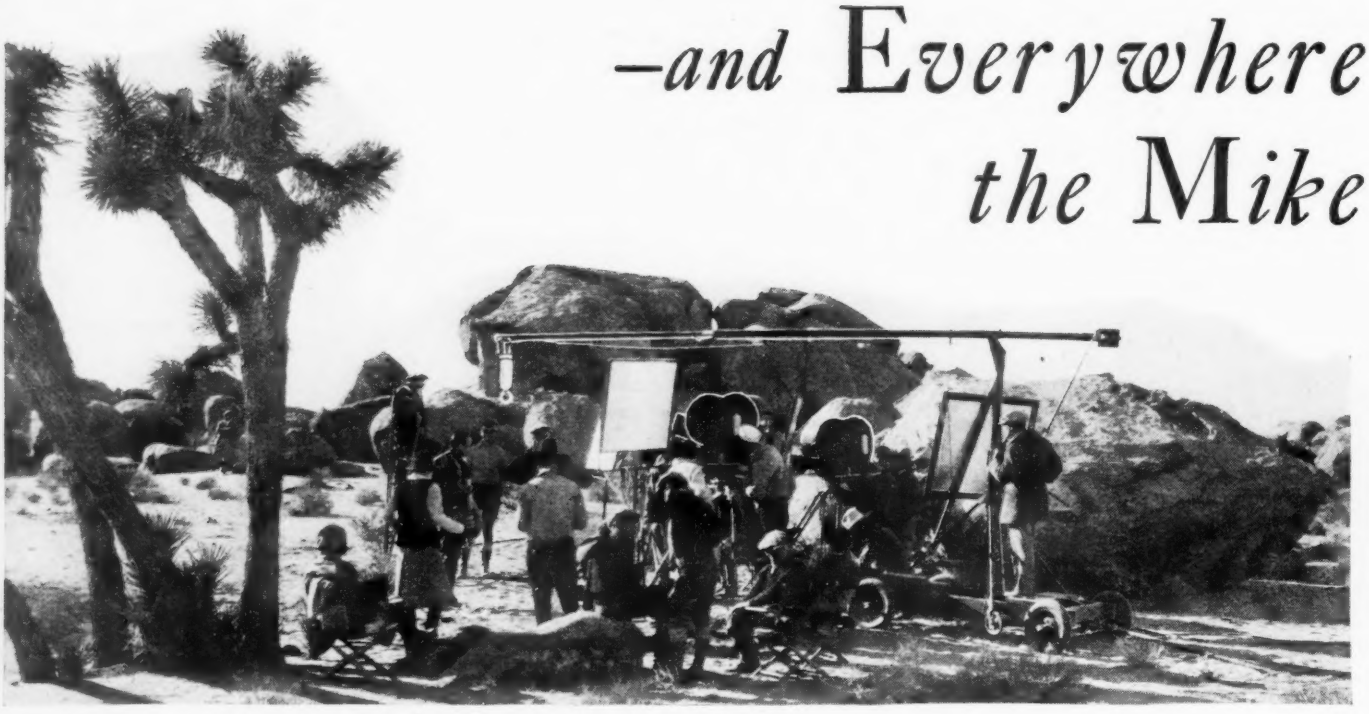
The Ohio Brass Company set to work upon the design of a new insulator to meet the specifications of the technicians. They brought forth a pattern consisting of four round brown porcelain columns grouped together between heavy steel plates, with a large shield at the top to keep out the weather. At the base was provided a chamber with an outlet normally sealed by a steel plug, which can be unscrewed, so that in case moisture should cause the insulators to leak, com-

(*Continued on page* 875)

A close-up view of one of the massive insulators which solved the problem



—and Everywhere the Mike



The talkie sound engineer is when he takes the microphone

By Carl

MOBILE recording in sound motion picture work includes newsreel applications and "location" jobs, a term which, in movie parlance, applies to any part of a production not made in the studio. The location may be on the grounds of a Beverly Hills estate, at the seashore, in the desert, or in any other place appropriate to the action of the photoplay. This article is concerned principally with the recording technique of dramatic productions on location.

The photographs at the top of this page show two "on location" scenes. Both clearly depict the microphone beams and "blimps," which, housing the cameras, reduce operating noises to a low level. The photo at the right, with the Mojave Desert background, shows the trucks which contain the recording equipment and engine-driven generators for current supply.

In many ways out-of-the-studio recording taxes the ingenuity of the sound technician to a greater extent than stage work, just as the broadcaster meets problems in field work which are not encountered in his own building. The hazards of temporary connections, damage to equipment in transit, extraneous noise and the limitations of portable equipment all must be faced. On the other hand, acoustic conditions, barring noise interference, may be as good or better.

The diagram, Fig. 1, shows the principal elements required for field recording. These components are all present in fixed recording, but in somewhat different forms. For example, in the studio the connections between the units are usually permanently installed in conduit. On location a good part of the connections is likely to run through temporary cables laid on the ground. In the studio the recorder may operate off the city power supply; on location a generator driven by a gasoline engine is often the source of power.

A single closed motor truck is generally used for the transportation of the equipment. Some exterior and interior views of typical trucks are illustrated. Usually two motor trucks are utilized, one for supplying power, the other for housing the amplifiers and recording equipment. In newsreel work all of the apparatus is in one truck, but the principles of operation are the same in both cases.

Truck Recording Equipment

While standardization in this field is far from complete, and there are wide variations in the equipment considered necessary for location recording by the various producers, the following list of master items covers the average outfit:

1. Motor truck, 1½-2 ton size.
2. Microphones (three to twelve), generally of the condenser type, with associated amplifiers.
3. Recording amplifier (one or two) with associated control and measuring equipment.
4. Film recorder (one or two).
5. Camera equipment, including means for synchronous driving.
6. Film magazines and accessories.
7. Intercommunicating telephones.
8. Connecting cables.
9. Power supply (inverted rotary converter or motor generator; storage batteries; dry batteries), and control equipment.

Mobile recording may be done on wax, but this is in the

Probably no one is better qualified to write about sound and its place in the motion picture industry than Carl Dreher, who is a well-known radio engineer. He was formerly Chief Engineer of the National Broadcasting Company, and later for the R. C. A. Photophone. He is now Director of Sound for the R. K. O. studios, at Hollywood, California.

This is the fifth in his series of articles describing the use of sound amplifier equipment in the production of talking moving pictures. These articles will prove a reliable source of information on the technique of the art, and should be of exceptional interest and value to those engaged in sound motion picture work.

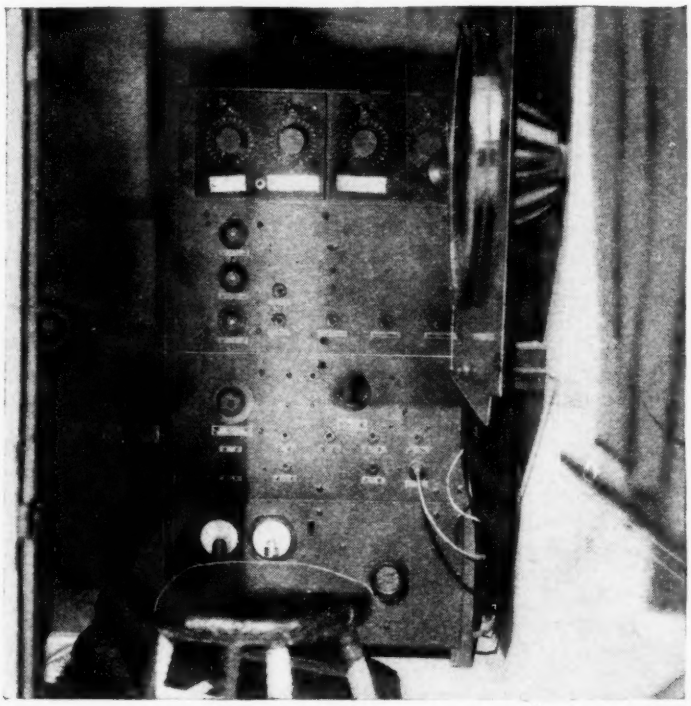
Following are the titles of articles from Mr. Dreher's pen, which have been published in RADIO NEWS, and the issues in which they appeared:

"Opportunities in the Radio and Audio Arts"..July, 1929
"The Analogy between Radio and the Talking Pictures" .....August, 1929
"When Camera Meets Mike".....December, 1929
"The Movies Come to Life".....February, 1930

that Mary Went Was Sure to Go

beset with all sorts of woe outdoors for "Location" Shots

Dreher



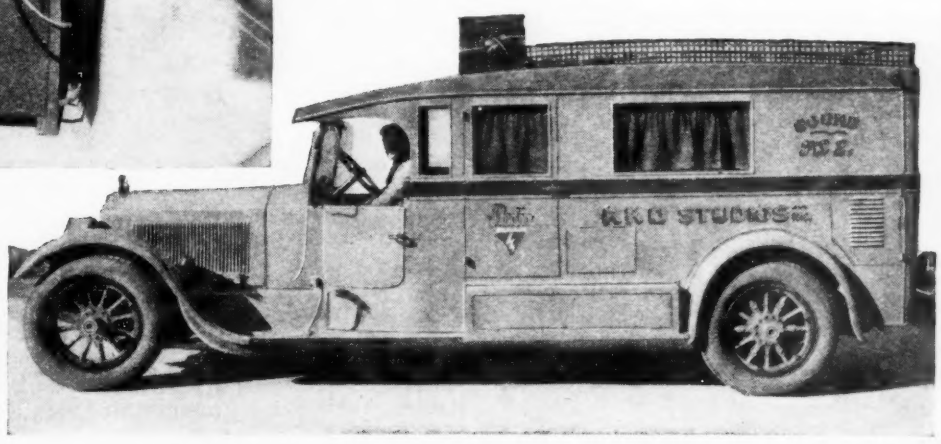
(Above) Interior view of the R. K. O. sound truck. A film recorder is at the left, although not visible in the photo. In the foreground may be seen the monitoring loud speaker. (Right) Exterior view of an R. K. O. sound truck. Some sound trucks are capable of a speed of 55 miles per hour, and are able to traverse the most difficult roads

nature of a special development, and the description here will be confined to recording on film.

Service Requirements

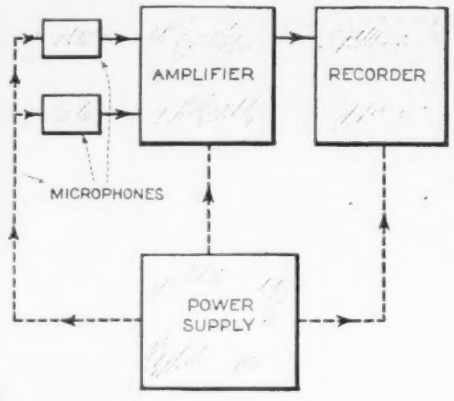
The service requirements of each of the main elements of a mobile recording system, as enumerated above, will be discussed briefly. The truck must be large enough to hold the apparatus and three or four operators. The 1½-ton size shown is adequate for most purposes, but a 2-ton machine affords more room and is usually preferable. Speed, ability to traverse all kinds of country, and easy riding qualities are all essential. Speed of every kind is always necessary in the movies, because of the inordinate expense of production—quite an ordinary picture may run to $10,000 a day on location. Ability to get anywhere is equally essential, since locations are not picked for accessibility alone; the truck may have to go up mountains or into desert country where the roads are merely paths in the sand. It is expected to reach any place a well-built passenger car with a powerful motor can penetrate. And because of its delicate equipment, the truck must ride easily. When it gets to the location, the lenses, tubes, and connections must be intact, to mention only a few of the components.

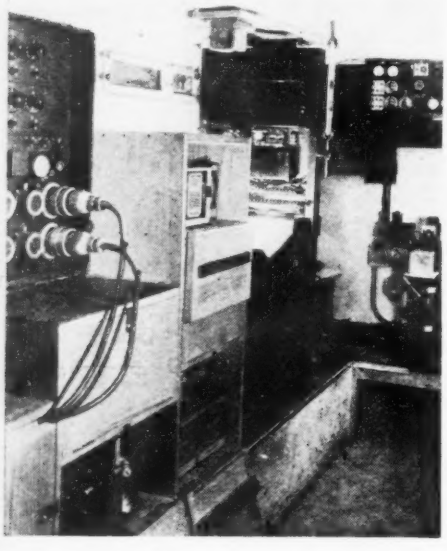
The condenser microphones supplied with a mobile recording channel generally do not differ from those with their associated shell-encased amplifiers, which have become standard in sound picture work because of their low background noise, ability to work in any position, and mobility during a "take." The recording amplifier and the recorder proper are also likely to be the same as in the studio. Only a few different models of film recorders have been developed, and most studios have only one type, so perforce the same equipment is used in fixed and



movable installations. There is more chance for variety in the amplifiers. While the studio types, suitably mounted, are often utilized, there is a tendency in the field to use tubes with low power consumption, and sometimes it is expedient to split the stages. For example, as in Fig. 2 the microphone may have two stages in its associated amplifier, followed by three stages in a portable, dry-battery operated amplifier of the broadcast type, located relatively near the pick-up point, this in turn feeding an output unit of one or two stages in the truck close to the recorder.

Camera equipment for dramatic location work is rarely carried in the sound truck. The camera department usually has a truck of its own, capable of carrying four cameras and the necessary tripods, dollies or camera trucks (equipment for photographing with the camera in motion) and other accessories. In newsreel work, however, the picture-taking equipment goes with the sound truck. In either case the cameras are driven synchronously with the recorder by electric motors and associated control equipment. Since picture and sound are usually photographed on separate films and combined in printing, marking facilities must be included. Marking is accomplished electrically by fogging the sound track and the edge of the picture film; a simpler expedient is to slap a pair of hinged sticks together near the microphone and within the camera field, resulting in characteristic marks on the sound track which are then matched with the picture frame showing the sticks meeting in the impact.

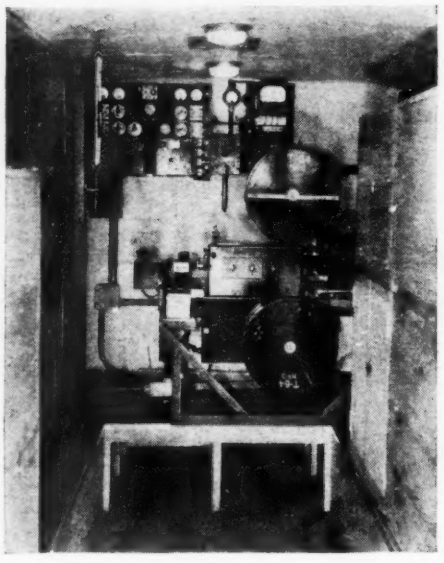




(Above) Schematic diagram of recording apparatus. (Left) From left to right, in this sound truck, are shown the mixing panel, battery box, amplifier rack and machine control panel

Sound trucks usually carry six to sixteen 1000-foot film magazines for recording, and of course means are provided for constantly renewing the supply of unexposed film. An ingenious accessory device is used which is illustrative of the need for resourcefulness in location work generally. Both the sound and camera departments must develop test strips of film on the spot, to ascertain exposure conditions, position and density of sound track, etc. This is accomplished by means of a light-tight box large enough to hold in the bottom a jar of developer, a jar of water, and a jar of fixing solution. A film magazine mounts on top over a trap door which permits access for filling the jars. One side of the box is black cloth with two sleeves in which the operator inserts his arms. An elastic band within each sleeve makes the joint light-tight. The exposed strip is pulled down out of the magazine, passed through the developer for an appropriate time, washed, immersed in the hypo jar for fixing, washed again, and removed for drying and inspection. For developing very small quantities of film where the photo-chemical elements are not critical, such a box is the equivalent of a dark room.

Not much need be said about intercommunicating telephones, which in general do not differ from the headsets and



Interior view of a Paramount sound truck, a complete laboratory on wheels

breast transmitters familiar in broadcast or picture studio practice. Cables and plugs, however, are of the utmost importance. The massive type of termination employed for microphone cables is shown on the left side of the Paramount sound truck. The currents passing through such a connection are insignificant and would normally require only the lightest kind of plug-and-socket combination, but in a business where noise-free, perfectly tight waterproof connections are vital, it pays to use only heavy contact equipment. The insertion having been made, the connection is locked by means of a heavy threaded ring. Note also the size of the rubber-covered cables and the mechanical reinforcement where the cable enters the plug.

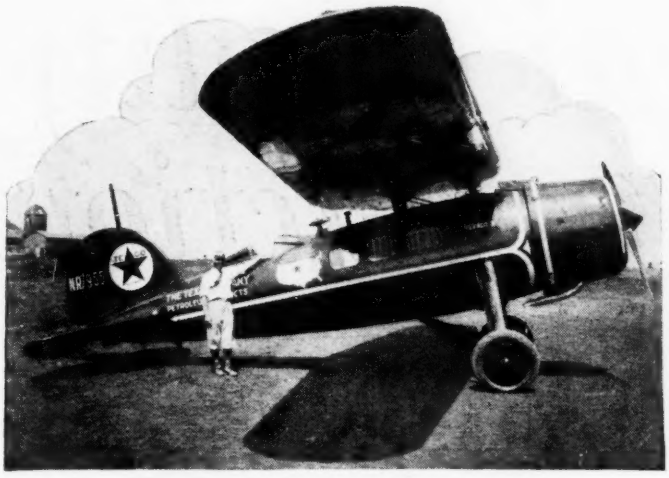
Mobile Power Supply

The principal problem in mobile recording is the electrical power supply for the equipment. This breaks down into the following elements:

1. Alternating current supply for interlocking cameras and sound recorders.
2. Filament supply for amplifier tubes and exposure lamps, marking, etc. (Usually 6-12 volt storage battery.)
3. High voltage for polarizing condenser transmitters and for amplifier plate supply.

The alternating voltage is usually 110/220 volts, 3 phase, 50/60 cycle. The reason for the alternative frequencies is that most of the Western picture studios are located in a section of Los Angeles where the municipal power supply is 50 cycles, and they usually prefer to use the same cyclage for studio and location work, so that all the recorders may be interchangeable. The a.c. generator is often not coupled directly to a gasoline engine because of the difficulty of maintaining the close speed regulation necessary. Instead, there may be a separate power truck in which the gasoline motor drives a d.c. generator which in turn supplies power to a d.c.-a.c. motor generator, or inverted rotary converter, with appropriate voltage regulators, speed regulating, controlling and metering equipment.

The trouble with this combination is that noise from the gasoline engine may interfere with recording near by. Hence a 32-volt storage battery is frequently utilized to supply power for a d.c.-a.c. motor generator set, the motor of which is a 32-volt d.c. machine. This arrangement is relatively quiet, and in the open air may be used a few hundred feet or less from the pick-up point. The storage battery is charged during the night, or when shooting is not in progress, by a gasoline-driven charging generator, or, if an electric power supply is available, through a resistance or rectifiers. In newsreel work, for example, the truck is generally stored in a garage overnight, and both d.c. and a.c. chargers are included in the equipment, so that it is necessary only to connect a cable to the power supply. On location, however, the company may be working far from any electric power supply, and hence the ultimate source of power must be a gasoline engine. This may be the automotive engine itself, equipped with a power (*Continued on page* 867)



The radio-equipped Lockheed Air Express flown by Capt. Hawks in his record-breaking flights

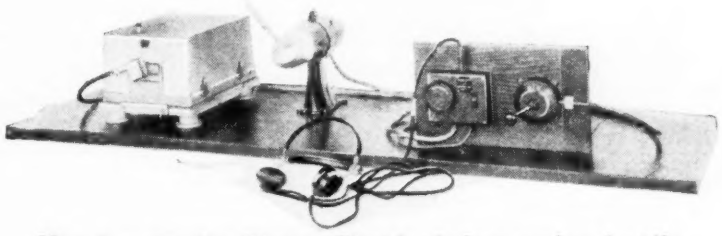
Capt. Frank M. Hawks, holder of the East to West and West to East speed records, in the control cockpit of his plane

How My Radio Helped Me Break the Transcontinental Air Record

By picking up weather reports I was enabled to avoid storms and fog and take advantage of favorable winds

By Captain Frank M. Hawks

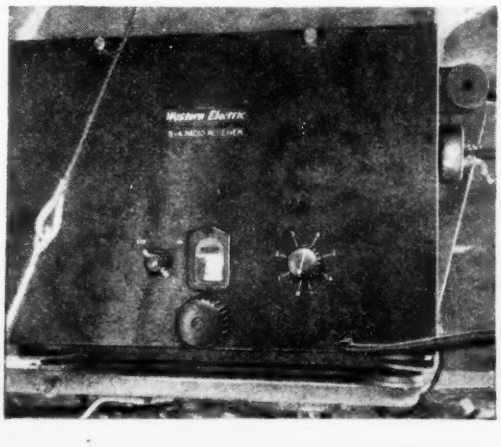
TO those readers who are technically inclined and who might be interested in the characteristics of the Western Electric radio equipment which I used in my Lockheed Air Express, Texaco 5, the plane which holds both transcontinental speed records, I shall divide this data into two divisions.



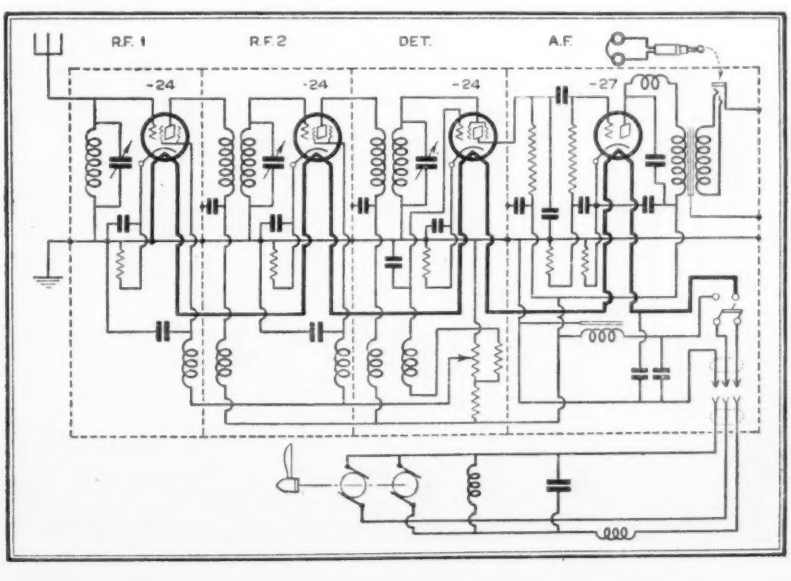
Here is a complete Western Electric airplane receiver installation consisting of receiver, wind-driven generator and remote control panel

First, the electrical characteristics: This set covers a range of from 600 to 12,000 meters and is entirely remote-controlled. The circuit consists of two stages of radio-frequency amplification, a detector and one stage of audio-frequency amplification. Heater type screen-grid tubes are used in the r.f. and detector stages. This type of tube, used as a space-charge grid detector, permits very high sensitivity. The input or antenna stage is provided with a special input filter to avoid interference from unwanted stations.

Second, the physical characteristics: the receiver is made of duralumin, and its dimensions are approximately 6″ x 10″ x 12″. The weight is approximately 16½ pounds. This receiver is arranged with its own shock-absorbing platform, permitting easy assembly and removal from the plane for servicing. There are two remote-control units, thereby permitting the receiver to be mounted in any convenient location in the plane. Located in the pilot's cockpit, they consist of a volume control and a remote tuning control. Usually the power is supplied to the filaments directly from a twelve-volt (*Continued on page* 866)

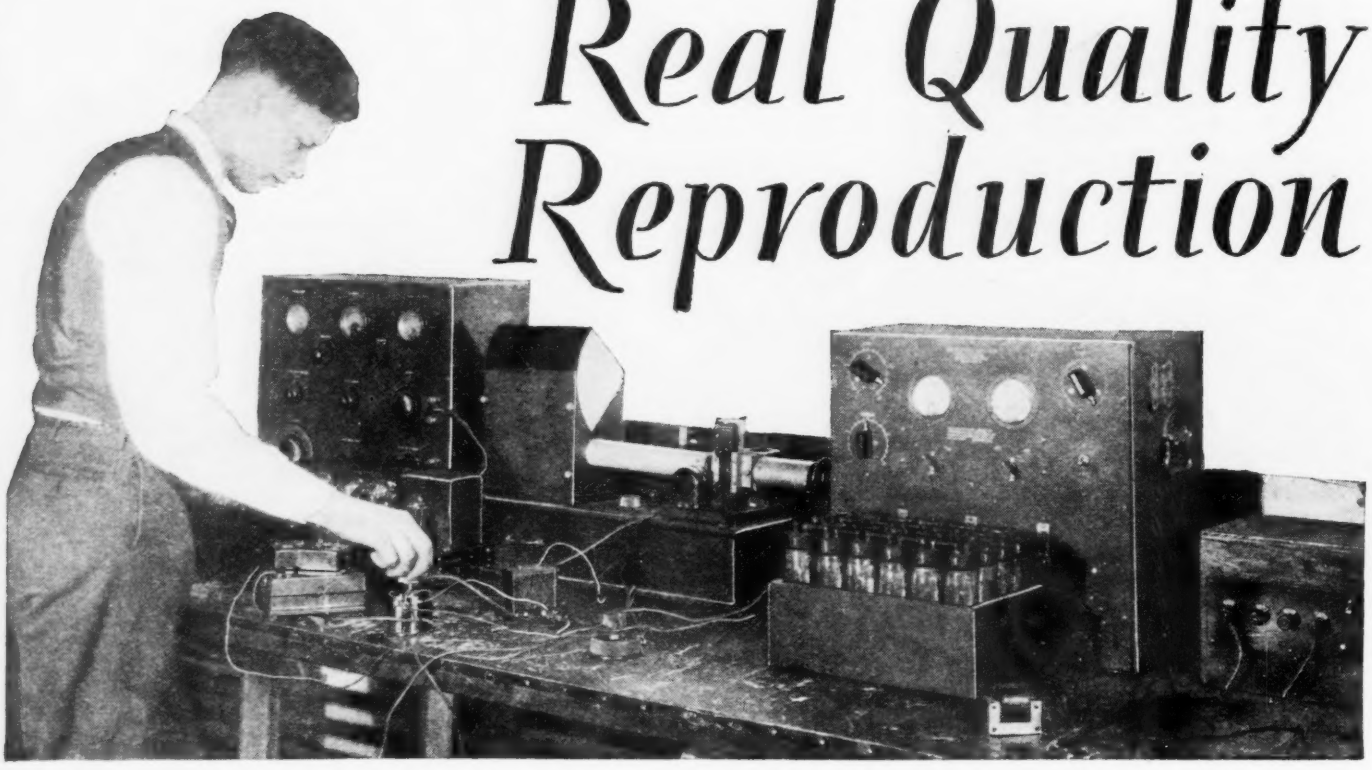


Compactness distinguishes the Western Electric 8A airplane receiver used by Capt. Hawks in his transcontinental dashes



To the right, the circuit employed in the 8A receiver. It consists of two r.f. stages, a detector and one resistance-coupled audio stage

Real Quality Reproduction



A discussion of wave-form distortion in audio equipment—its causes, and its effect upon tone.

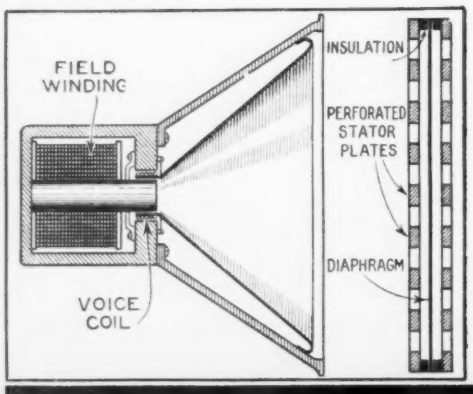
IT has become the custom, in reporting on audio transformers and loud speakers, to give the frequency characteristics as though they were the whole story. Unfortunately, they are only half of it. To get perfect reproduction it is necessary to obtain an exact counterpart of the impressed wave not only in frequency but in form.

Speech is a very subtle thing. It takes the average human being about five years to acquire the first essentials of it. The actual mastery of the fine points comes much later. These fine points of inflection are largely lost in reproduction; speech from a phonograph is usually difficult to understand, and even with the elaborate equipment used in talking movies only a select few sound well through the microphone. However, good reproduction of wave form is by no means impossible, as is demonstrated by the fact that stage stars turned down in Hollywood have no difficulty in complaining to New York over the telephone.

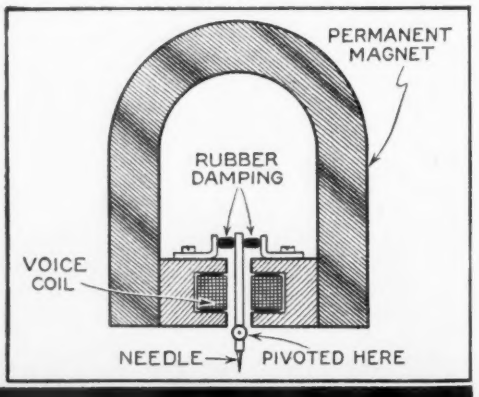
It is the purpose of this article to discuss wave-form distortion in an elementary way. For the sake of simplicity let us start with an ideal system consisting of a "perfect" loud

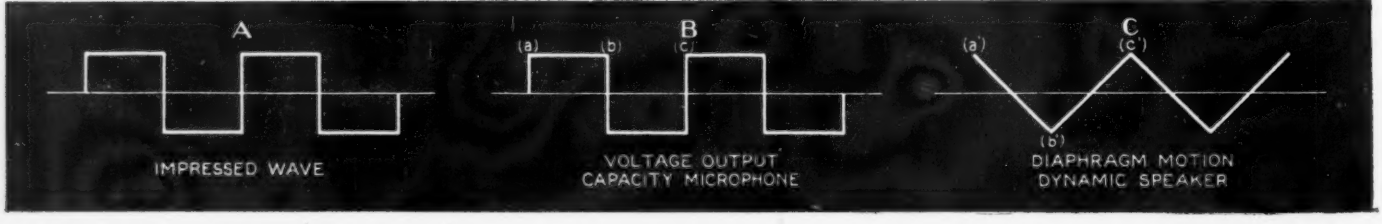
Phonograph pick-up with cover removed

Cross sectional views of dynamic (left) and electrostatic (right) reproducers



Inner details of a pick up. (Below) Changes which take place in wave-forms





A laboratory oscillograph for studying wave forms

By Graydon Smith

speaker, a "perfect" amplifier and a "perfect" microphone, all of present-day type. Modern speakers can be represented by two types for the purpose of discussion: the electrostatic and the dynamic. The electrostatic speaker is in reality a variable condenser, in which the usual rotor is replaced by an elastic diaphragm, and the stator is replaced by one or more fixed plates. When a voltage is impressed on this device, the diaphragm will deflect until its mechanical stiffness just balances the electrostatic force. This deflection is proportional to the voltage.

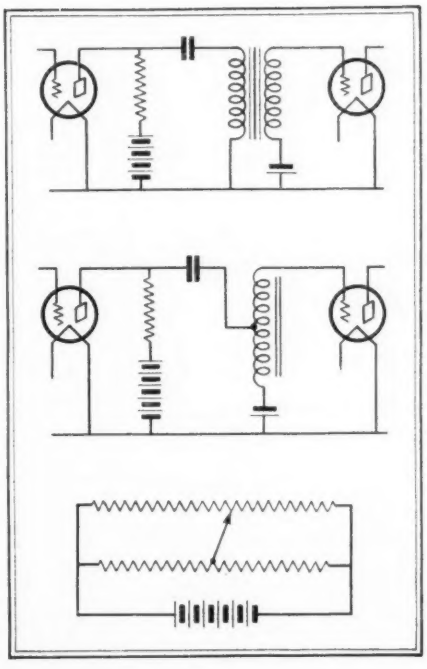
The dynamic speaker, on the other hand, is quite different. It can be regarded as an electric motor. It consists of a small coil or armature fastened to a freely floating cone. This coil is linked by a strong magnetic field. When a voltage is applied to the coil, a force is exerted on it, moving both coil and cone. This motion induces a back electromotive force in the coil which bucks the impressed voltage. The coil will speed up until this back E. M. F. just balances the impressed voltage (assuming no coil resistance, and hence no voltage drop*), after which the coil will move at constant speed. The velocity of the coil and cone is thus proportional to the voltage impressed, and therefore the deflection is proportional to the product of the voltage and the time.

Now let us see what happens in the microphone. Like the loud speakers, microphones can be classified in two general types: the condenser microphone and the magnetic microphone. The first of these is very similar to an electrostatic speaker. It consists of a fixed plate and an elastic diaphragm, properly insulated from each other. These plates form a variable condenser whose capacity is inversely proportional to the separation of the plates. Furthermore, since the voltage across a condenser varies inversely with the capacity (if the charge remains constant), it follows that the voltage across the plates of the microphone will be proportional to the deflection. This is the exact opposite of the electrostatic speaker, and if the two are connected through a perfect amplifier, perfect reproduction of the original wave will result.

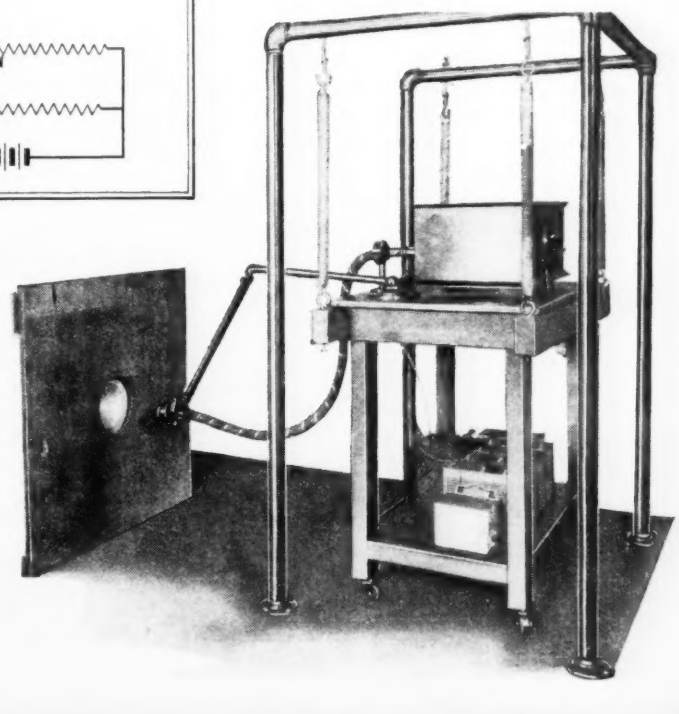
All phonograph pick-ups are based on the principle which governed the old-style magnetic microphone. It consists of a coil and a suitable magnetic circuit so arranged that the flux through the coil is in proportion to the deflection of the diaphragm or phonograph needle. A movement of this needle will therefore induce a voltage in the coil, this voltage, of course, being proportional to the rate of change of magnetic flux. The output voltage is then proportional to the velocity of the diaphragm or needle. This, again, is the opposite of the dynamic speaker, so that the combination of these two will also give perfect reproduction.

But here is the difficulty. Most studios use condenser microphones. Modern radios use dynamic speakers. What happens then?

Suppose that the flat-topped wave shown at A is impressed on the microphone. This will give rise to a voltage proportional at every instant to the impressed wave, as shown at B. This voltage will cause the speaker to move with a speed proportional to it. Thus at the instant (a), the voltage in curve A is seen to be at a maximum value which is maintained until (b) is reached. During this period the speaker diaphragm deflects at constant speed from point (a)′ to point (b)′. The voltage then drops instantaneously from the positive maximum at (*Continued on page* 863)

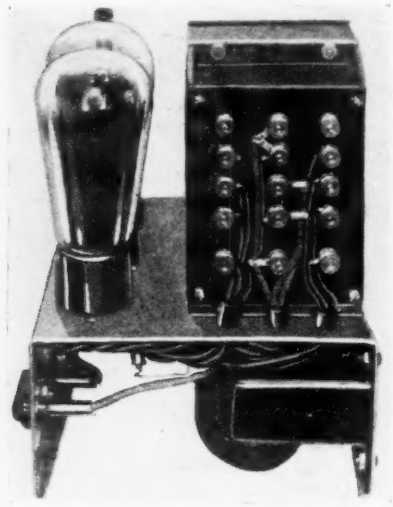


(Left) Two coupling systems: (Figure 1, above) A unique method of combining resistance with transformer couplings. (Figure 2, center) This auto-transformer arrangement gives greater gain per stage. (Figure 3, below) The action of a pick-up is likened to a potentiometer

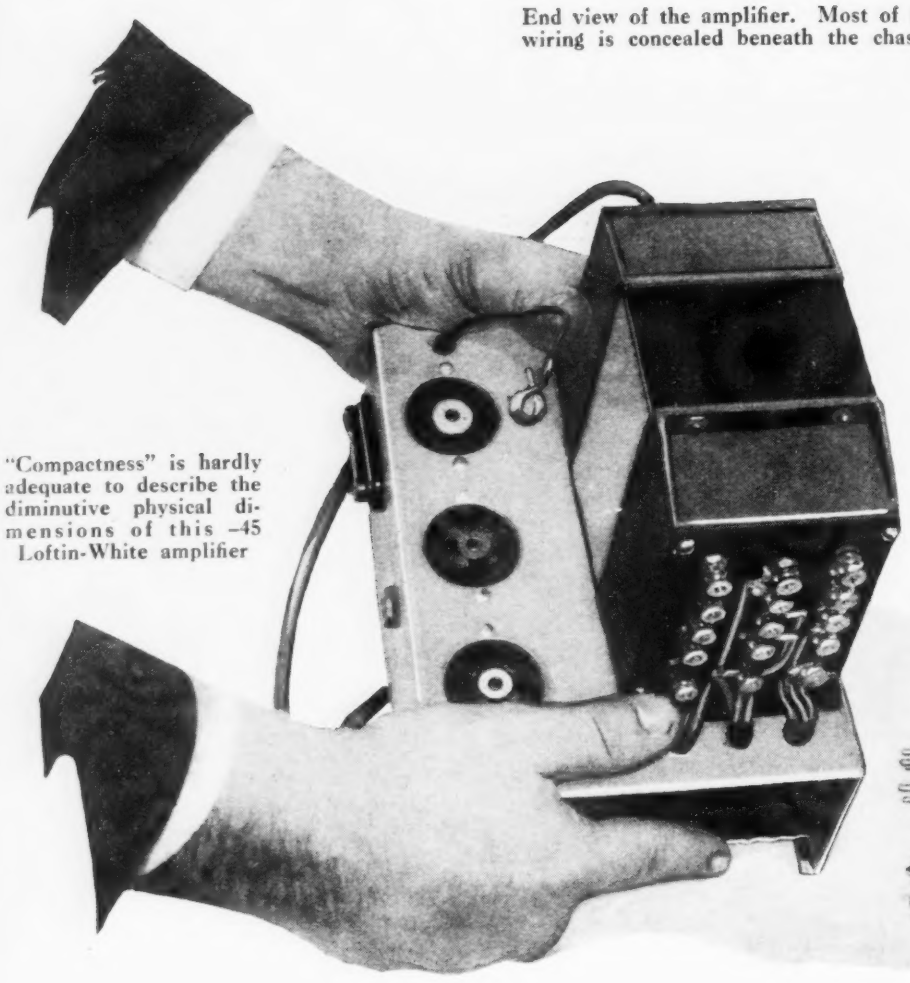


(Below) A novel arrangement for measuring the response characteristics of loud speakers and pick-ups

*That is, in a "perfect" loud speaker.



End view of the amplifier. Most of the wiring is concealed beneath the chassis



"Compactness" is hardly adequate to describe the diminutive physical dimensions of this –45 Loftin-White amplifier

Building the Loftin-

Complete details and constants for able engineering development

By Commander Edward H.

THIS is the second article to be published containing the only authorized circuit constants of the Loftin-White amplifier, and the third of a series written by Commander Loftin and S. Young White exclusively for RADIO NEWS. Future articles will contain further details about the construction of this remarkable amplifier, which is conceded to be the most outstanding radio development in recent years, and destined to bring about far-reaching changes in the radio manufacturing world.

Future issues of RADIO NEWS will contain more details about the construction and the many applications of this almost revolutionary development.

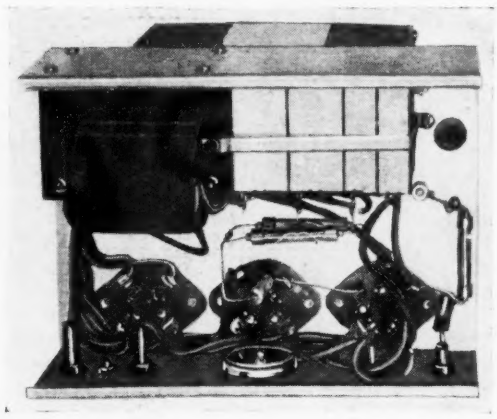
IN this third of our series of articles we had planned to discuss the underlying features of a.c. operation of direct-coupled cascaded tube systems, but we have received so many insistent requests for more details as to constructional features of a type of our system that we have taken occasion to design a 2-tube system from parts we believe generally available or obtainable, and having a –45 output tube as one modification over the –50 tube of the system described in our preceding article. The arrangement is diagrammatically shown in Fig. 1.

It is assumed that our preceding RADIO NEWS articles have been or will be read by those now interested, so that our present data are stated in the light of what we have heretofore covered. The output tube VT2 of Fig. 1 is of the –45 type, and therefore is operated with 250 volts plate potential and 50 volts negative grid potential, giving the normal –45 tube plate current of 30 milliamperes, these figures and others to follow being, of course, approximate within practical limits with normal line voltage. Once the system is properly set up the usual variations in line voltage will have negligible effect.

Input tube VT1 is of the –24 type, and for the constants hereafter given should preferably have the mu of 400 normal to commercial tubes of this type. Because of occasional leakage between the cathode and heater of commercial indirectly heated cathode tubes, we follow the customary practice of using separate heater windings on power transformer PT for tubes VT1 and VT2. It is preferable to connect one side of the heater of VT1 to point *a*.

Resistance arm R1, carrying the 30 milliamperes of plate current of VT2, is made up of four elements, R1a, P, R1c and R1d, totaling approximately 6100 ohms, and consequently, a potential of 183 volts. R1a is 425 ohms, developing about 12 volts; P is 200 ohms, developing about 6 volts; R1c is 775 ohms, developing about 24 volts, and R1d is 4700 ohms, developing about 140 volts. Thus, to supply the 250 volts for the plate of tube VT2 and the 183 volts for the arm R1, the filter system must deliver a total of 433 volts.

A 280 type full-wave rectifier tube, RT, is supplied through



Ease of construction is evident here. Tubes, a transformer, one choke, resistors and fixed condensers are all that enter into the assembly

Simplicity of design dominates the Loftin-White amplifier. The circuit of this one is shown on page 802

White *Amplifier*

building one type of this remark- are given here for the first time

Loftin *and* S. Young White

a power transformer, PT, wound to deliver approximately 400 volts a.c. to each plate of the rectifier tube, from which to develop, through our filter, the 433 volts rectified current required as arrived at above. The filter comprises a condenser Cf, of 1 microfarad in our case, although a larger value may be used, and a choke L of 20 henries, also subject to increase if desired.

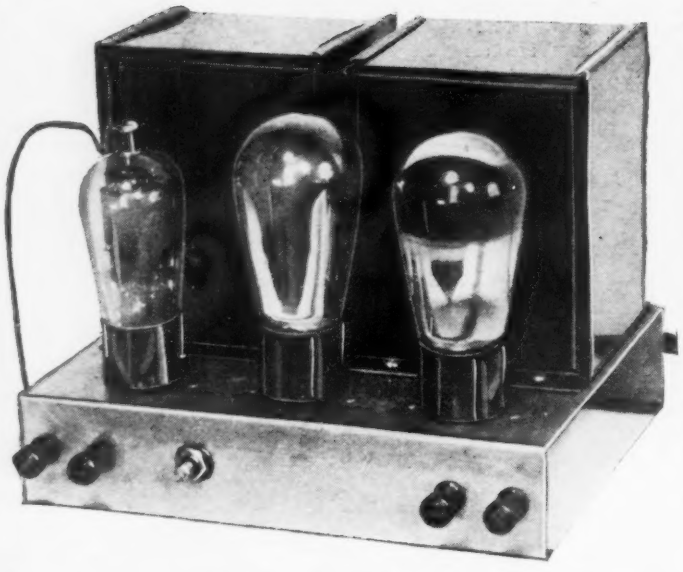
An output condenser C2 of 1 microfarad and a by-pass (around arm R1) condenser C3 of 1 microfarad are essential. The output capacity C2 may be increased one or more microfarads, as indicated in dotted lines by C′2, in which event an additional filter condenser C′f, indicated in dotted lines, of a value corresponding to that of C′2, must be included, but no change should be made in the value of C3, irrespective of what is done to C′2 and C′f. The purposes and reasons for these modifications to include C′2 and C′f, and the necessity for not changing the value of C3, wil be stated later.

Coupling resistor Rc has a value of ½ megohm, and should preferably have very low distributed capacity. We usually employ the internally treated glass tube type of resistors for coupling purposes. We have heretofore stated that the values of the coupling resistors may be varied through wide ranges for obtaining a variety of results, but suggest making no change in Rc in the present model until we have fully explained the procedure, the reasons therefor, the accompanying other modification of constants, and the results to be expected.

Resistor R3, as explained in our preceding article, coöperates with resistor R1a to develop initial grid bias for VT1, and to vary automatically the bias for drift correction or stabilizing, and for desirable bias change when receiving carrier currents of different intensities. In the present embodiment R3 is 50,000 ohms, and, with the combined plate and screen-grid current of VT1, develops a negative potential of about 14 volts with respect to the grid of VT1, which, opposed by about 12 positive volts in resistor R1a, provides an initial bias of about 2 negative volts for the grid of VT1. The current through R3 is only about 280 microamperes, so that the wattage or heat characteristics of this resistor are in nowise severe, thus making a suitable resistor for this function easily obtainable.

Resistor R5, of about 25,000 ohms, and resistor R6, of about 100,000 ohms (values not critical), divide the 250 plate volts of VT2 into two portions, with a junction at point *e*, to which Rc is connected, giving about 50 volts between points *d* and *e* while increasing the current drain on the filter a negiligible amount. These 50 volts added to the 183 volts across R1, less the opposed 14 volts in R3, give approximately 220 volts between the cathode of VT1 and filament of VT2. In order to follow out one of our principles of operation, termed by us "symmetrical operation," these 220 volts are equally divided (110 volts each) between the filament-plate impedances of VT1 and coupling resistor Rc. In other words, we substantially match the internal and external output impedances even when dealing with the very high internal output impedance of screen-grid tubes.

Having previously pointed out that the –45 tube used at



Economy is an outstanding feature of the Loftin-White system of amplification as exemplified in the one shown above, built from the Electrad kit. The constants for the –45 Loftin-White amplifier, to the right, are as follows: R1a, 425 ohms; P, 200 ohms; R1c, 775 ohms; R1d, 4700 ohms; Rc, ½ megohm; R3, 50,000 ohms; R5, 25,000 ohms; R6, 100,000 ohms; Cf, C2, C3, 1 mfd.; L, 20 henries. PU indicates the phonograph pickup and VC the pickup's volume control

VT2 requires but 50 volts grid bias, the 110 volts established across Rc are of course far too much for bias. The 50 volts of R5 are, however, opposed to this 110 volts in Rc with respect to grid and filament of VT2, so that the effective grid bias of VT2 is so close to normal that the self-adjusting characteristics of the system will automatically adjust for correct operation.

Taking into consideration the opposed potentials in R3 and R1a, the point *c* is about 28 volts positive to the cathode of VT1 (see preceding details of potentials); that is, the screen-grid of VT1 is operated about 28 volts positive.

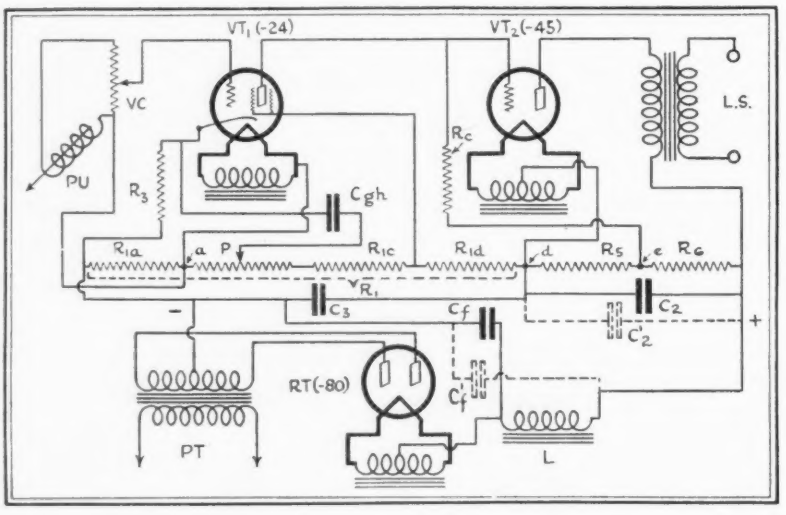
The hum-bucking, grid filtering and screen-grid filtering features of the present arrangement include a modification of the arrangements for these effects described in our preceding RADIO NEWS article. Here we use but one condenser, Cgh, for these several functions, the condenser having a capacity value of 1 microfarad, and being connected between the cathode of VT1 and a contact arm on a 200-ohm potentiometer P. It is apparent that the 50,000 ohms of R3, coöperating with the 1 microfarad of Cgh, constitutes an effective filter for hum currents and signal currents, with respect to both grid and screen grid of VT1, but the variable connection of condenser Cgh to potentiometer P permits selection of a point where the hum introduced on the grid of VT1 is just right in phase and amplitude to buck out the hum currents arising throughout the system. The effectiveness, and the reasons therefor, of hum-bucking in direct-coupled systems were discussed in our preceding article.

In the arrangement of the preceding article a separate condenser of large value connected directly between the grid circuit and the cathode of VT1 was used for filtering, and a separate condenser of small value connected to a selected point in arm R1 was used for hum-bucking. Because of the small value of the hum-bucking condenser the hum-bucking potential selected from arm R1 had to be large. Obviously with the present arrangement the large value of condenser Cgh permits selecting a hum-bucking potential from arm R1 of much lesser value. In other words, in the present case potentiometer P is nearer the negative end of R1 than in the arrangement of the preceding article.

Output condenser C2 serves to localize signal current in the output of VT2, and thus lessen the signal current in arm R1, which may give rise to feed-back troubles. C2 is of course increasingly less effective for this purpose, the lower the signal current frequencies. By-pass condenser C3 serves to shunt both hum currents and signal currents from arm R1. While C3 was not used in the arrangement of our preceding article, its use makes the matter of fixedly selecting the hum-bucking point in potentiometer P, with expectation of being satisfactory for hum suppression for any change of tube at VT1, more certain, and gives a better hum suppression for all tubes. In fact, when properly adjusted the hum is so low that a meter reading of it is quite difficult, unless there are leakage or grid emission currents in the particular tube used.

Once a location of potentiometer P and adjustment of its contact is had with by-pass condenser C3 in position, the value of this condenser should not be altered. The new value will not satisfy the original location and adjustment of P.

We have previously pointed out that additional output capacity C'2 and filter capacity C'f are not essential. They make for extreme refinement in the matter of delaying the falling off of amplification at frequencies so low that they are not reproduced in the present construction of dynamic and other speakers, so that the improvement is only detectable in precision measuring apparatus. However, in the event C'2 is added to include 1 microfarad or more, C'f should be added in capacity to match the addition in C'2.



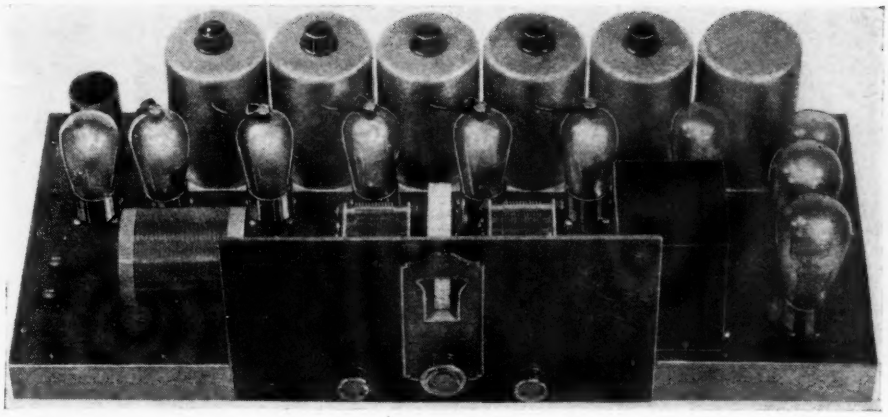
The input of VT1 is shown to include a phonograph pick-up, PU, connected through a conventional resistance volume control, VC. Connection should be made directly in the input circuit as shown, a step-up transformer being both unnecessary and undesirable. The pick-up may be substituted by a conventional tunable circuit for radio work, but we do not advise trying to include any radio-frequency stages in advance of Fig. 1 until we have had opportunity to cover this phase of extension of the system. The operation of the arrangement directly from an antenna will give adequate idea of its extreme effectiveness both in sensitivity and selectivity as a detector-amplier.

A dynamic or other loud speaker may be used, but in view of the perfection of the frequency characteristic of the system we recommend using the very best loud speaker obtainable. In any event, once the system is properly set up, any distortion detected is a measure of the imperfection of the pick-up, phonograph records and loud speaker being used.

With the system properly set up a correct reading milliammeter in the plate circuit of VT2 should show approximately 30 milliamperes current with a line potential of 110 volts, and should not fluctuate noticeably during operation, provided output tube VT2 is not pushed to overloading.

The overall gain is in the neighborhood of 300, giving more than enough volume for phonographic operation with any satisfactory pick-up. The frequency characteristic is extremely good throughout the entire sound range. Not being corrected for feed-back in the output tube, there is a slight falling off at 10,000 cycles, but not enough to be noticeable in any reproducing apparatus now available. The detection and amplification of carrier current is most effective, and it is believed that a trial of this form of functioning will surprise those acquainted with what is accomplished by the usual apparatus employed.

Beginning but briefly, in the space remaining for this article, our theoretical comments on direct-coupled systems, the first important observation is that the (*Continued on page* 873)



Ten tubes are used in this superheterodyne, the final audio stage employing a pair of –45's. The intermediate stages have separate tuning controls for purposes of circuit alignment

By W. H. Hollister

A New Superheterodyne Makes Its Bow

This Ten-Tube Receiver Incorporates the Features of a High-Gain, Screen-Grid, Intermediate-Frequency Amplifier With Full A.C. Operation

FOR the last year and a half independent investigators have been putting a great deal of time and thought into the correct design of an intermediate amplifier, to be used in the superheterodyne circuit in conjunction with the screen-grid tube.

During the summer of 1928 a very successful receiver known as the Lincoln 8-80 was designed, using four type –22 d.c. screen-grid tubes. In this receiver many new features were introduced, such as the elimination of the many harmonics found in the super circuit of the past, the stabilization of the circuit so that no shielding was needed for the screen-grid tubes, the securing of a higher gain from the tubes, thus allowing distant signals to be brought in with great heavy volume, and, at the same time, obtaining a fine degree of selectivity with stable operation.

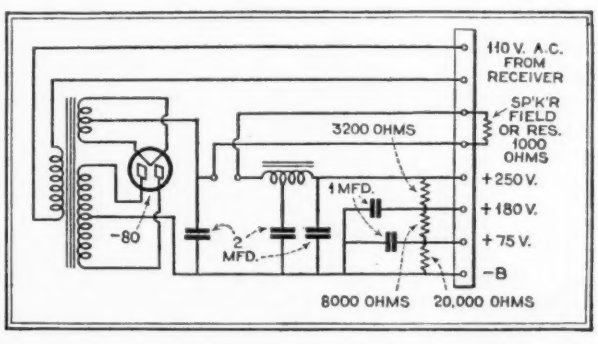
The experience gained by the development of several models of this type of receiver has enabled the designers to perfect a radically new receiver, employing features previously thought to be impractical.

As is known, the transformer has proved to be the most practical and efficient means of coupling vacuum tubes for making a cascade amplifier. There are four variations of transformer coupling, namely: untuned, tuned primary, tuned secondary, and tuned primary and secondary.

The untuned transformer is very successful in low-frequency amplifiers, but at high frequencies very little gain can be obtained because of the short-circuiting effect of the input and output impedance of the three-element vacuum tube.

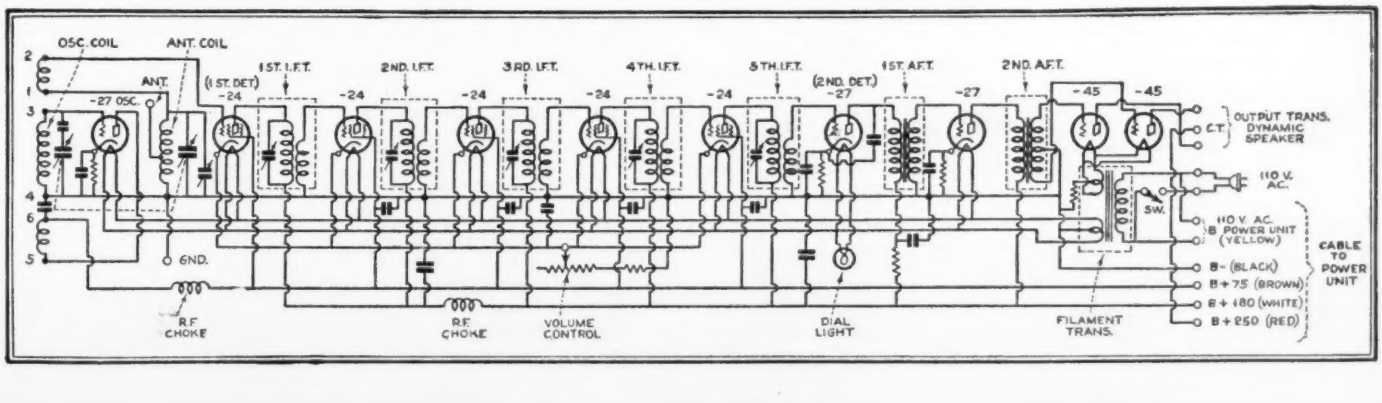
At a frequency of 500 kilocycles it is possible to get an impedance of several hundred thousand ohms from a tuned circuit. This impedance increases with both the efficiency as well as the inductance of the coil. In a three-electrode tube, with a plate-to-filament resistance of less than 20,000 ohms, a very large impedance in the primary of the transformer is not necessary in order to obtain a considerable portion of the voltage to be generated across the primary. This means that it does not take very close coupling

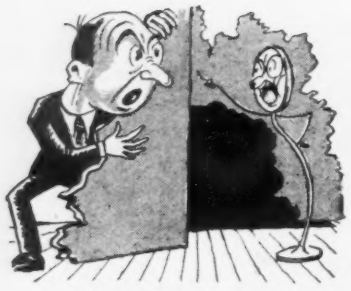
(*Continued on page* 869)



The circuit of the power supply is shown at the right. A single –80, or full-wave rectifier, is employed

The arrangement of tubes used: oscillator, –27; first detector and four i.f. stages, –24; second detector and first audio stage, –27; second audio, two –45's in push-pull





don't peek behind the mike

Disillusionment Awaits the Listener Whose Curiosity Leads Him Into a Radio Broadcasting Studio

By Dale Wimbrow

Illustrated by J. P. Ronan

THERE seems to be a general craving to look behind the scenes, see behind the curtain, or sorta pierce the veil of the unknown, so to speak. Especially has this been true of show business in general, and of movies and radio in particular.

I question whether the craving should be satisfied. Sometimes knowing too much becomes more irksome than knowing not enough.

Without becoming lugubrious let me point out that the Creator has seen fit to clothe certain things in mystery and uncertainty. Nor do I regard this as mere happenstance. On the contrary, I believe it to be a deliberate method instituted by an intelligence too shrewd to show or allow mankind to know too much.

Sprouting a grassy lawn from a a board floor in zero weather

Never till the day I hold a lily in my hand and assume some measure of dignity at last, shall I forget the first time I visited Hollywood and saw them run the Grand Canal of Venice into a papier-mâché trough, from a fire hydrant, while a Venetian swain below ogled a fair damsel above with her head through a window. He was standing on a spot where a wooden support ran beneath the flimsy structure representing the bank, while she maintained her precarious equilibrium on a stepladder behind the false front.

Later, when I saw the finished picture, the buildings along the Grand Canal looked as old as time and as stable as eternity. Needless to say my enjoyment was spoiled. 'Twas all I could do to restrain audible speculations as to what would have happened had the gallant teetered a bit; and all the way through the showing I half expected to see the sweet Venetian Juliet take a nose dive into the Canal.

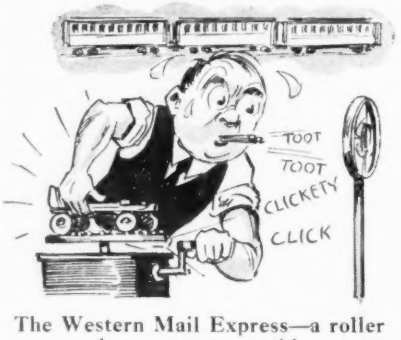
Ah, dear Picture Fan and Radio Listener, stay on your own side of the fence! We assure you with emphasis and unction that the grass is greener where you are. Sure, we have grass too, but a scrub billy goat would starve to death on it. Nay, he'd probably be poisoned, for our grass is dyed straw—sewed to gunny-sacks. For a fact, we can sprout a luscious lawn in five minutes on a board floor in zero weather!

A Chippendale studio ship in a gale

Any time I see a parka-hooded arctic hunter I begin to pant in sympathy. Up before my mind's eye comes a vision of sledge dogs and fur-booted "mounties" toiling through great drifts of rock salt and avenues of stunted hemlock. One swerve of the sledge would have made that hemlock forest look like the aftermath of a cyclone, for they had only been stuck deep enough in the salt to make 'em stand upright, and the actors—oh, yes. The actors were cussin' the realistic property man who had insisted that the costumes be actual fur. Each of them was undergoing a miniature Turkish bath, with not even a cool plunge to look forward to with relief.

And so it went—and so it goes in radio. You hear a subway train hittin' 'er up around the curves, and you want us to sit down and tell you that it's only Harry Swan running a roller skate around a turn-table. Harry confided to me the other day that he had been created all wrong. "Why?" I asked. "Because," grumbled he, "they expect me to be an airyplane, a submarine, and a traffic cop all at one time, and I ain't no durn centipede—I'm goin' in fer character parts."

Not long ago WOR presented the chariot race of Ben Hur. I said WOR presented it, but I wish to amend that. The Lone Star Rangers and yours truly presented it. The basis of my amendment is that the race was essentially made possible by the horses, and we were the horses. A couple more experiences like that and I'll beat any fire horse that ever munched hay, to the tap of the gong. It was a cinch for Ben Hur (whom I think was Allyn Jocelyn) to climb up in his imaginary chariot and cluck encouragingly to the team, but from then on it was distinctly up to the team. I was the rear section of the "off" horse in the winning combination and Fred Vettell did duty as the fore part. We stood in one spot on a wooden platform and worked our feet up and down in a sort of double expansion goose-step. I placed my face to his back and my hands on his hips and we proceeded to swoop down that etheristic race course. Every time we came in front of Nero's box in the home stretch, we stamped harder, then easier, and softer as the race supposedly continued on into



The Western Mail Express—a roller skate on a turn-table

the quarter stretch, back field, then gradually increased the crescendo as we rounded into the home stretch again.

Never have I heard of such a short race course; we were constantly in front of the grandstand. It must have lasted nearly a millennium, and all the time Freddy and I were trying to decide whether our composite horse was a pacer, runner or trotter. John Quine and Emerson Williams, who represented the opposing turn-out, either decided that their horse was a single-footer or else they were loafing on the job. One time, coming up the home stretch for the ninety-nine thousandth lap, I panted out to Freddy, "Hey, what gait is this Hur guy's horse supposed to have?" Three laps later Freddy gasps out, "I don't know and I ain't got breath enough to answer fool questions." Still the chariots continued to sweep around the arena, and just as I was about to give up the ghost I looked over at John and Emerson single-footin' along and looking comparatively fresh. I got mad and calling on my reserve, I rounded the next curve on two wheels. Then came the great crash when Ben Hur sideswiped his opponent and rode on to victory. Part of that crash was my knees hittin' the board platform.

"His wife uses a whisk-broom to get him out of bed"

Under cover of the cheering of the populace, which had stood there sardonically leering while five singing gentlemen wilted their collars, and generally made asses, instead of horses, of themselves, I staggered through the crowd toward the studio exit. Leonard Cox rushed up. "Keep yer dignity, man," he hissed, "keep on yer dignity." "Dignity hell!" I wheezed. "It's all I can do to keep on my feet."

If any of you heard Ben Hur's chariot race you heard five good men and true lose fifty pounds of healthy fat.

Yes, so it goes. Wendell Hall insists that I'm the best cow he ever heard. That comes from playin' a ukulele on the farm, but anyhow I can always rely on Wendell to cast me for the part anytime he has a cow character. I enjoy it, though, because I like cows; they've got such expressive eyes. So any time I play a cow part I think about her eyes. Thus is my artistry sustained.

Once we had a canary bird on a program. Dickey was a marvel. He could whistle the scale chromatic or aromatic. He was a real canary champ. But if any of you had happened to glance into the studio while Dickey was twittering his stuff you'd have seen a two-hundred-pound gent with head cocked to one side, and lips puckered up as if inviting a kiss from Mother Nature. We have another famous canary at Columbia Broadcasting System. Harry Swan looks like a burglar, but he whistles like a feathered prima donna.

And there's Jimmy Whipple's program "40-Fathom Trawlers." You're welcome in Jimmy's office if he isn't too busy, but a certain chair therein is decidedly taboo. He guards it with watchful and zealous care. It's only an old, decrepit, loose-jointed piece of junk, that some antique shop palmed off as Chippendale, or what have you. Well, it's chipped all right, and cracked and pock-marked, but something must serve as the creaking of masts, cordage and rigging as the good ship heads out to sea.

The studio chariot-race

For several years radio fans have fondly believed that Art Gilham, "The Whispering Pianist," is fat, forty and bald. Gilham, who has entertained in every broadcasting station in the country many times, over a period of seven years, tells his audience that he is bald-headed and weighs 357 pounds. As a matter of fact, he wears huge tortoise-rimmed "specs," has a shock of hair like a floor mop, and is so thin that his wife uses a whisk-broom to get him out of bed. He talks incessantly about his coffee. If audiences only knew the truth, he drinks it often and black, in order to keep from becoming entirely transparent.

Oh, I could go on and on and on, but this article can't last forever, and besides I must preserve some of the secrets of the business. P. T. Barnum and Tex Guinan were both right in their day. Them days is gone now, for people no longer care to be regarded as suckers, but they do delight in mystery, doubt, and uncertainty. Women finally got wise to themselves and, lo, how the mighty (short) skirts have fallen. Although, if I may be allowed an irrelevance, they'll be back up again as soon as we men have forgotten which women were bow-legged. But getting back to the folks. Even while reveling in mystery, they still reach out in the mistaken endeavor to discover things they never should know.

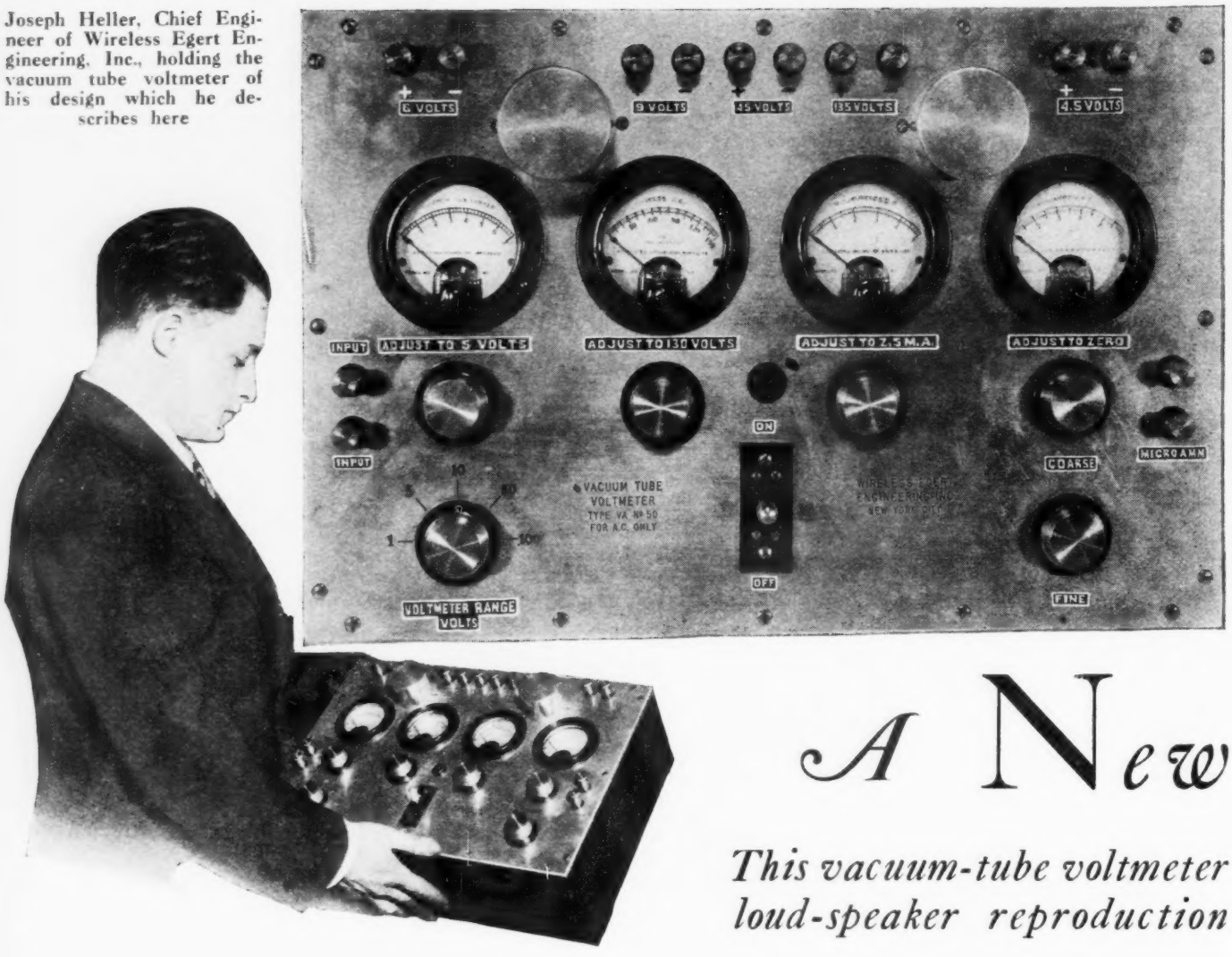
"A two-hundred-pound canary"

Don't do it, people. Stay on the other side of the studio door while you're still happy. You've had the curtain held back for about fifteen minutes while I've tried to show you that "all is not gold that glitters," and from now on I shall insist that the closed door remain closed.

While you peeped behind the scenes, you may have had a giggle at what you saw, but at that you'll never believe in a chariot race again. I'll assure you I shall never participate in another. We've both been cured, but what have you gained? Part of the illusion is gone, and with it lots of the enjoyment. Take my advice, and have faith in us. Express your faith in letters. Tell us our train wreck was a bang-up smash, that our chariot race moved you to tears, and that our canary bird warbled with all the inspiration of spring, but as you value your diversion and entertainment, stay in front of your loud speaker.

Express your faith in letters

Joseph Heller, Chief Engineer of Wireless Egert Engineering, Inc., holding the vacuum tube voltmeter of his design which he describes here



A New

This vacuum-tube voltmeter loud-speaker reproduction

¶ The vacuum tube voltmeter will measure very feeble voltages without drawing any current from the circuit.

¶ The meter is interchangeable on either a.c. or d.c. circuits, and calibration on one range is accurate for all others.

¶ An accidental application of high voltage will neither injure the instrument nor affect it in any way.

¶ The voltmeter also is useful for determining the performance of an amplifier at different frequencies and with different circuit characteristics.

IN the laboratory it is often necessary to measure the voltage of a circuit which carries little current—if any—or we might want to measure a potential and not a voltage drop. The usual type of voltmeter is of course out of the question, for the same reason that the old type of voltmeter is unsuited for measuring B-eliminator voltages: *i.e.*, the voltmeter itself draws current. When it is desired to measure voltages where no current may be drawn from the circuit, use is generally made of a vacuum-tube voltmeter.

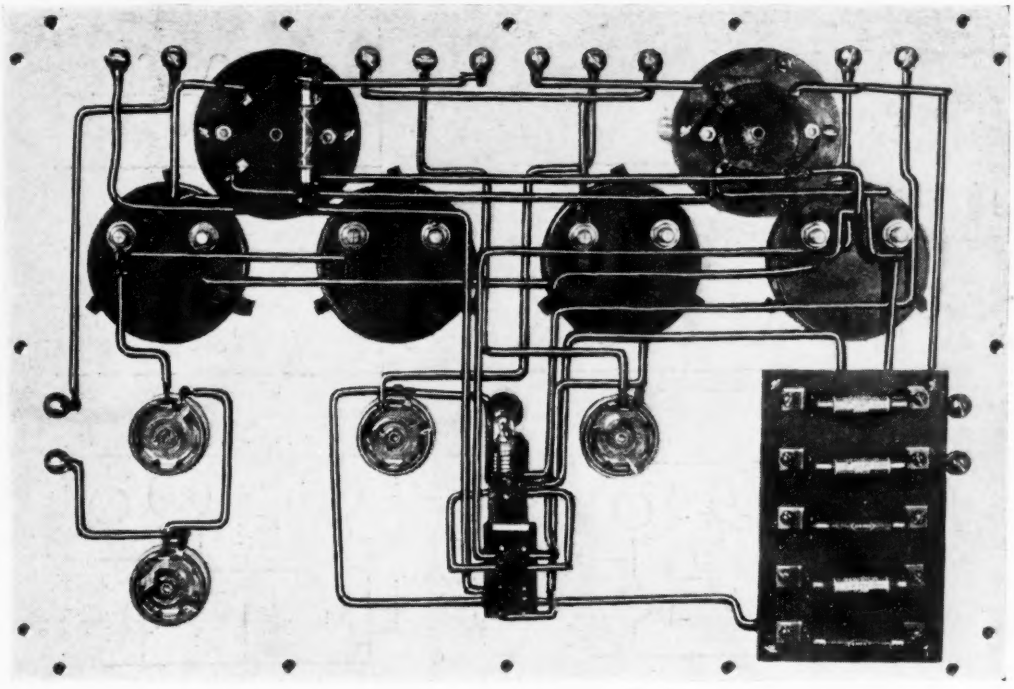
Aside from the no-current advantage of this type of voltmeter, there is the added advantage that an accidental application of a high voltage will not affect the instrument or injure it in any way.

The vacuum-tube voltmeter described here is equally accurate on either d.c. or a.c. and on any frequency, either audio or radio, up to 1500 kilocycles.

Most vacuum-tube voltmeters utilize what is known as the lower bend of the grid voltage-plate current curve. The curves are obtained in a rather simple way. All that is necessary is the simple circuit shown in Fig. 1a. The tap on potentiometer R1 is turned until 4 volts of positive bias is indicated on voltmeter "V" and the reading of milliammeter "A" is noted. This reading is then plotted at some such point as "a" on the curve on Fig. 1b. R1 is then adjusted to give a slightly lower voltage reading on voltmeter "V," and again the current through milliammeter "A" is noted. This, when plotted, will give some such point as "b" on the curve in Fig. 1. Continuing in this manner we get points c, d, on the curve. At this point battery "C" is reversed and the readings continued. We will then get such points as f, g, h, etc., and draw the complete curve.

Many interesting facts can be derived from this curve. Suppose, for instance, that the tube was left biased at point "g" which is equivalent to a grid bias of —4 volts. If the circuit of Fig. 1a is broken at the point "x," and an alternating current of three volts impressed across the break, then the grid voltage would appear as in Fig. 1c. The plate current would be very similar to this, as shown in Fig. 1d. Since this curve is symmetrical, its average value is shown by the dotted line. The last two curves mentioned would be alike in shape, because the magnitude of the plate current change would be practically equal whether the grid swung positively or negatively. The condition we have at this time would compare to that obtaining in a good amplifier stage.

If we should, however, bias our grid to point "j" on Fig. 1b, which corresponds to about —9 volts, and again impress an alternating voltage of three volts at point "X," we will get, as a result, curves similar to those in Figs. 1e and 1f. It can be seen that the grid voltage curve is similar to that of the first case. A marked difference is present, however, in the plate current curve. The upper half of the wave remains practically the same, but the lower half has been cut off. The voltage



By
Joseph I. Heller

Tool for the *Serviceman*

has many uses such as testing the perfection of and measuring the gain of any receiver circuit

value shown by the dotted line will, in this case, be displaced from the axis. We have the condition, therefore, of an alternating voltage causing an effective change in the plate current. This will make itself evident by the higher reading of the milliammeter "A." Continuing in this way it can be easily seen that, if we should further increase the grid bias negatively, there will be a change during the positive half cycle of the impressed alternating voltage, but no sensible change during the negative half; and this is exactly how the usual type of vacuum tube voltmeter operates.

There are certain requirements which will both increase the ease of operation and the reliability of such an instrument. To begin with, a high negative bias does not mean that the plate current has been entirely cut off. While the small current which does remain would not make itself evident in a high range milliameter, it will make itself very troublesome in the sensitive micro-ammeter generally used. The reading can be reduced to zero in the manner shown in Fig. 2. By varying rheostat "R" we can send through the meter a current from battery "K," equal and opposite to the current set up by the plate battery. The meter will read zero and any change in plate current will make itself evident by a deviation from zero. In the actual construction of this instrument, the voltmeter, V1, Fig. 2, should be included as well as a filament voltmeter V3. The fixed resistance R2 in Fig. 2 is of the value of several megohms, and is included in the circuit so that the voltmeter can be used to measure the output from circuits coupled by condensers. If we did not include this resistance and attempted to use the voltmeter on a circuit isolated by a condenser, our voltmeter tube would not receive any bias and would be useless for measurement work.

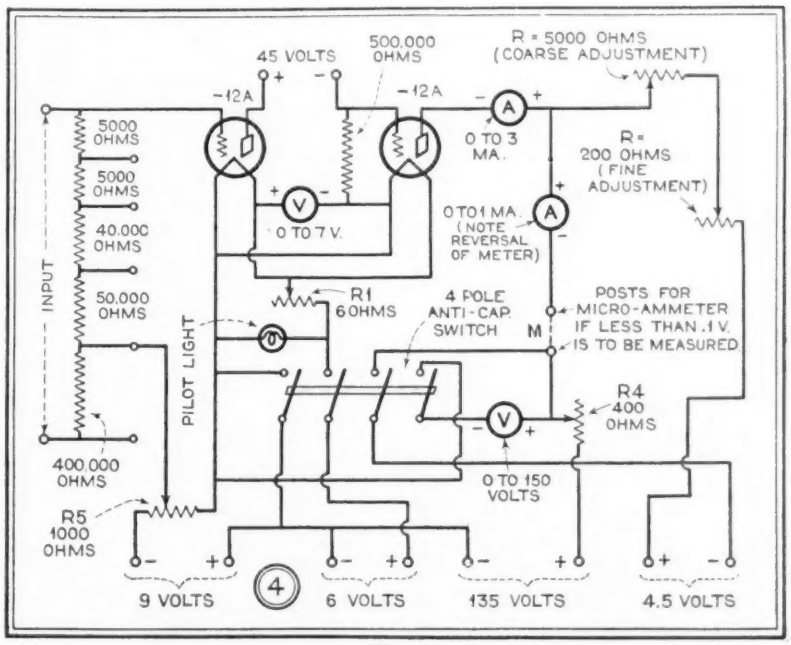
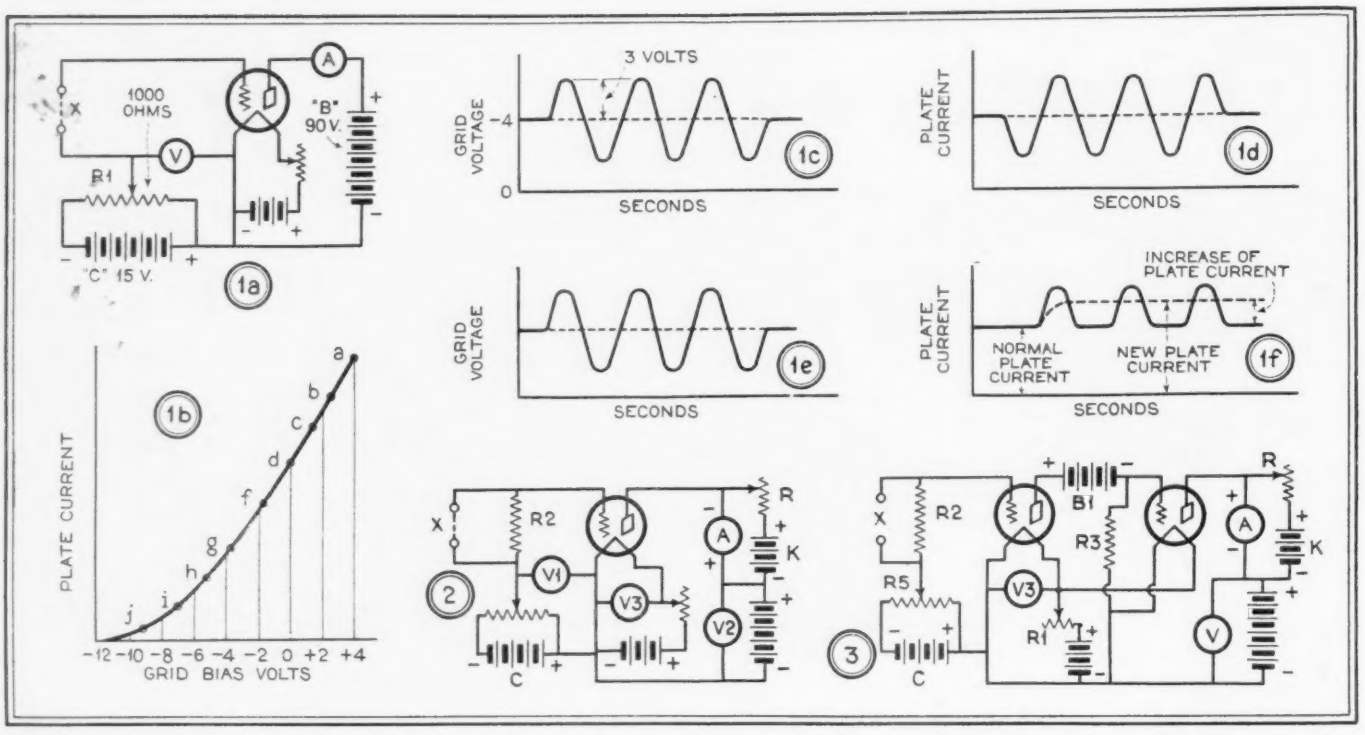


Fig. 4

The complete circuit diagram of the vacuum tube voltmeter, an instrument which is fast gaining favor with the more serious-minded servicemen and experimenters because of the high degree of accuracy in measurement work which can be attained by its use

In its present form this voltmeter is not useful for measuring voltages below one volt without the addition of another instrument—a micro-ammeter—while the voltmeter, without this instrument and without any changes, is perfectly useful



In Fig. 1a is shown the circuit which is employed to obtain the characteristic curve of the tube to be used. The curve thus obtained is shown in Fig. 1b. Figs. 1c and 1d show the wave form of the grid potential and plate current, respectively, when an alternating current of 3 volts is impressed on the grid of the tube. In Figs. 1e and 1f the curves which would result, if the grid were biased to about 9 volts, are shown. Fig. 2 shows the circuit arrangement for obtaining zero reading of the instrument. Fig. 3 shows the circuit for amplifying and reading direct currents

for voltages ranging from one volt upwards, it would not be sensitive enough for voltages under one volt. If it were necessary only to measure alternating voltages, a simple amplifier would suffice. If, however, we want to make this instrument as electrically flexible as possible, we should want it to measure direct as well as alternating voltages. Since the ordinary amplifier will not amplify a direct voltage it becomes necessary to make use of what is known as a current amplifier. In most respects this amplifier is exactly like that of the common type, with the important exception that no condensers or transformers are permissible. To accomplish our end in this matter we arrange a circuit as shown in Fig. 3. It will be noted that the battery B1 is in an unusual position, and that we have replaced the micro-ammeter by resistance R3. In operation, a change of plate current through the voltmeter tube will cause a voltage drop across R3. Since this changes the grid voltage on the amplifier tube, the plate current through micro-ammeter "A" will also change, and we have as a result a vacuum tube voltmeter and an associated current amplifier which can be used to measure either d.c. or a.c. voltages.

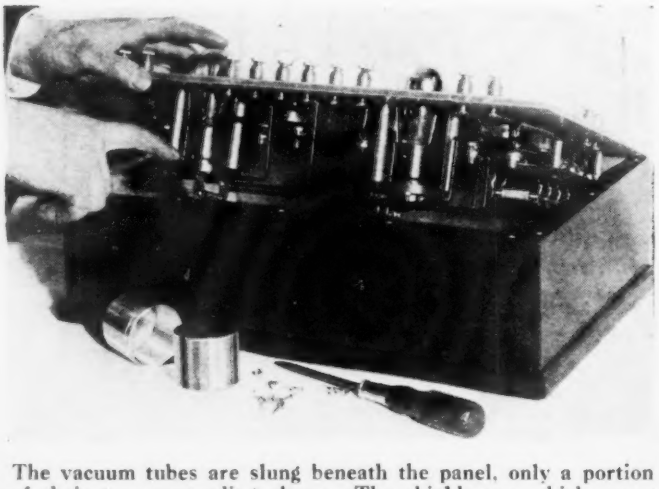
We might call attention at this point to the change in polarity of meter A in Figs. 2 and 3. When connected as in Fig. 2 an impressed voltage will cause an increase in the reading; but when the amplifier tube is coupled to the voltmeter tube, the rise in plate current through the latter will decrease the plate current through the ammeter.

Now we will discuss the problem involved in the design and construction of the apparatus for laboratory work. One of the first prerequisites for such an instrument is the necessity of constancy of result. If a reading is taken at one time, we shall want a reading repeated at some later date to agree with the first. Also, since no one can say for what purpose the apparatus will be used eventually, we shall want a range from the lowest to the highest voltage that is likely to be measured. A further desirability is the inclusion of some method whereby the apparatus can be made ready for use without the necessity of laboratory standards of any sort.

In order to make sure of the first condition it is necessary only to make certain that all parts are the finest obtainable, and that the batteries and meters used are in good condition.

To make our instrument meet any reasonable demand for range, we might make use of the input arrangement shown in Fig. 4. This is essentially a non-inductive potentiometer, and is so arranged that the load upon the circuit to be measured is constant at 500,000 ohms. The values of separate resistances we used are indicated in Fig. 4.

We can satisfy the last requisite by a novel arrangement for setting the meters. If the reader will refer to Fig. 4, as he proceeds, he should have no difficulty in following the discussion.



The vacuum tubes are slung beneath the panel, only a portion of their tops protruding above. The shield caps which cover them are shown in front of the case

Its Use

The first adjustment is that of filament voltage, accomplished through the rotation of R1. With the filaments set at five volts the plate voltmeter "V" is adjusted to read 130 volts by means of rheostat R4. R5 is now turned until the plate current through the amplifier tube is 2.5 milliamperes. This adjustment is the key to the whole affair; it will be noticed that by adjusting the grid bias of one tube, we automatically adjust the plate current through both tubes to their correct value. The concluding adjustment is carried out by adjusting "R" until the milliameter "A" reads zero.

A study of the photographs will give a good idea of the method used in constructing the model. A top panel is made of aluminum ¼" thick, the edges were chamfered, and the top given a silvery satin finish by fine emery and steel wool.

In order to make the apparatus as unvarying as possible, it was wired with sturdy No. 12 round busbar covered with spaghetti. Resistance values as well as (*Continued on page* 850)

The Modern Music Box

By motions of the hands in the air anyone can play this new musical instrument comprising vacuum tubes and a loud speaker

By Stuart C. Mahanay

Leon Theremin playing the instrument of his invention

THE Radio-Victor Corporation of America has just placed on the market for home use a new and amazing musical instrument, which anyone can play by merely moving the hands in the air above it. Although the new "ether-wave" Theremin is neither a radio nor a phonograph, it is based on well-known radio principles.

The instrument itself resembles an orchestra conductor's stand with two metal antennae. It has no keyboard, strings, reeds or other mechanical aids for manipulation. It may be connected directly with the house lighting current like a radio set, and may be placed anywhere, requiring no other apparatus than an ordinary loud speaker. One antenna, a vertical metal rod at the top, controls tone, or pitch—the "voice" of the Theremin. The other antenna is in the form of a looped horizontal bar, at the left side, and controls volume, or the intensity of the music.

When the human hand is brought into the sensitive electrical field surrounding the vertical antenna the field is so affected that audio-frequency notes, or musical sounds, are produced. These are amplified by vacuum tubes within the cabinet, and passed through the loud speaker. As the hand approaches the vertical antenna the pitch of the sounds becomes higher; as the hand is withdrawn, the pitch becomes lower.

When the hand is lowered over the horizontal, looped antenna the volume is lessened, in minute gradations, down to the faintest whisper; when the hand is raised the volume is increased, by similar delicate gradations, to an intensity exceeding that of the most powerful stringed instrument.

The sounds originate from two oscillating circuits within the Theremin, which produce a heterodyne beat note, varied and controlled by the position of the player's hand in relation to the vertical antenna. The Theremin employs eight tubes, a screen grid -24, three -27's, a -120, two -71-A's, and a -80 for power supply.

It is claimed that anyone who can hum or whistle a tune is able to produce whatever music he wishes from the Theremin. Little technical knowledge, practice or study is necessary in order to play it.

The tone is rich and full and the range is about three octaves. It may be adjusted practically for any three consecutive octaves in the musical scale. In the lower range the instrument's tone resembles that of the bassoon, string bass and other wood-wind instruments; further up the scale the tone is extraordinarily like that of a 'cello; (*Continued on page* 854)

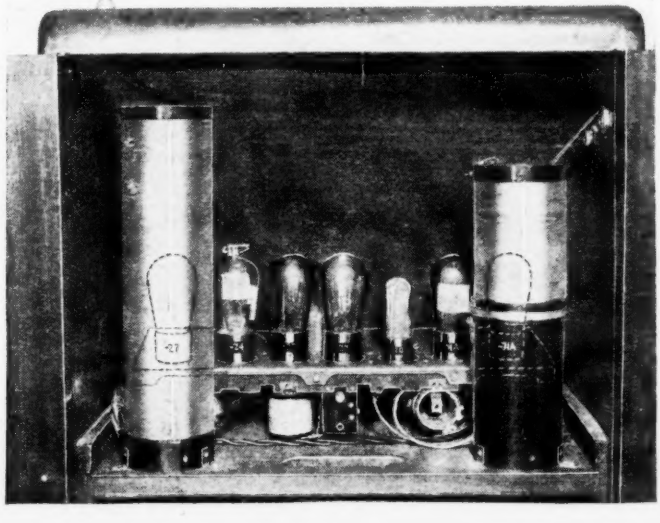
LEON THEREMIN was born in 1896 in Leningrad, Russia. He attended the school of Physics and Mathematics at the University of St. Petersburg, and later the Polytechnic Institute of the Russian capital, meanwhile pursuing a higher musical education under the tutelage of the well-known Russian 'cellist, A. Garpf.

From 1915 to 1917 he served in the army as radio-technical instructor in the college for officers.

After the war he continued his scientific investigations in the fields of radio, astronomy, television and musical acoustics.

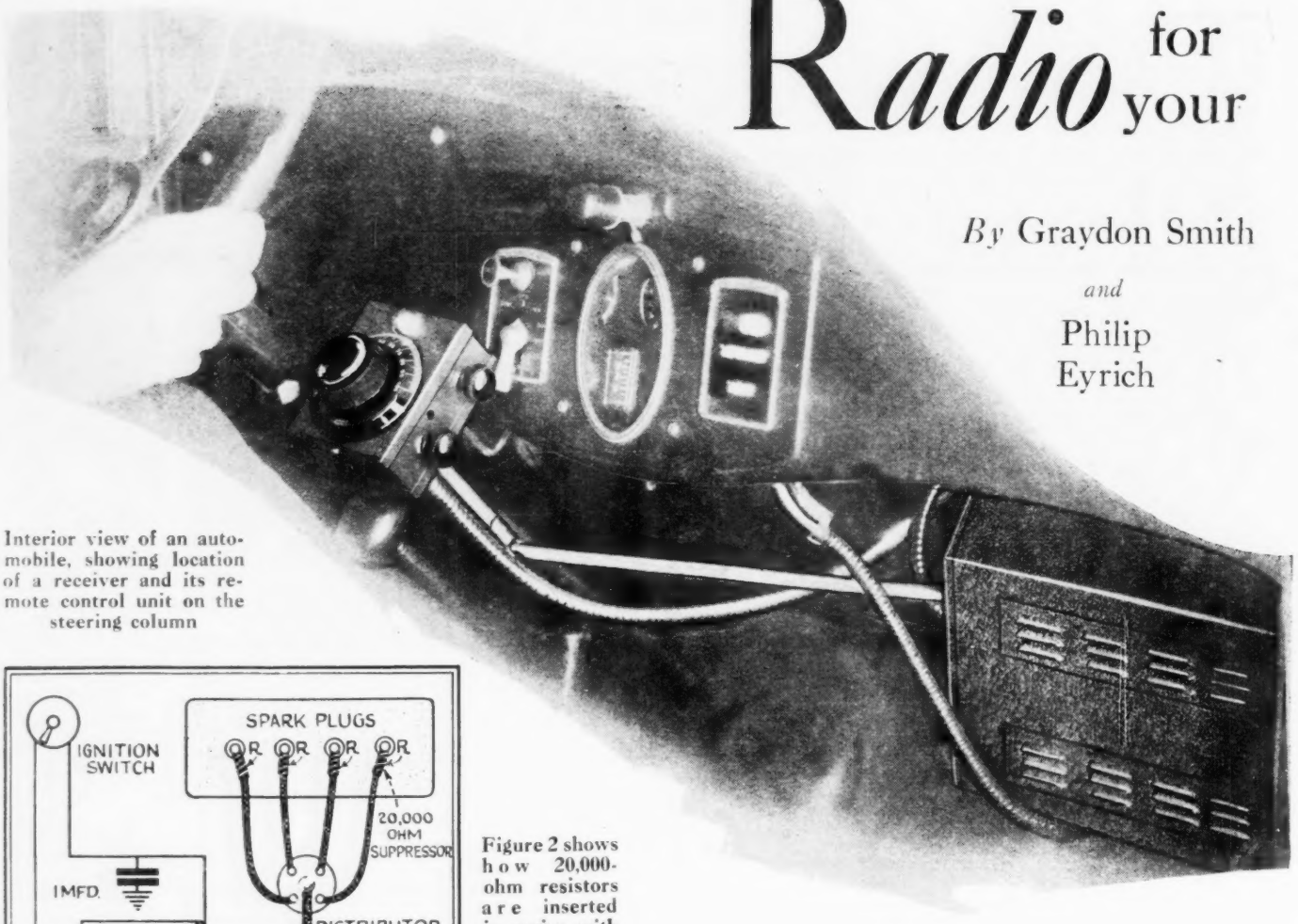
The Thereminvox is one of his achievements in the realm of musical art. The invention has already attracted widespread attention, not only in Europe, but in the United States as well. Its consequences and their future influence upon the course of musical development are being awaited and studied with the closest interest throughout the world of science and art.

Interior view of the Theremin



Radio for your

By Graydon Smith
and
Philip Eyrich



Interior view of an automobile, showing location of a receiver and its remote control unit on the steering column

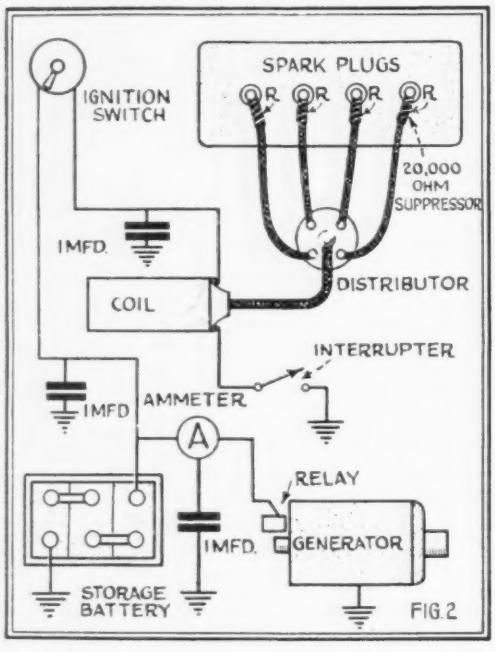


Figure 2 shows how 20,000-ohm resistors are inserted in series with spark plug leads and fixed condensers connected in other parts of the automobile's electrical system in order to eliminate interference from this source

This Article is Dedicated:

¶ *To those who take pride in the appointment of a fine car;*

¶ *To those who prefer to sit out dances to music of their own selection;*

¶ *To those who have tickets to the "Big Game," but cannot find a parking place;*

¶ *To the million garage mechanics who, unknown to themselves, are about to enter the Radio Servicing business;*

¶ *To the butcher who will get all the money the publisher pays for this article.*

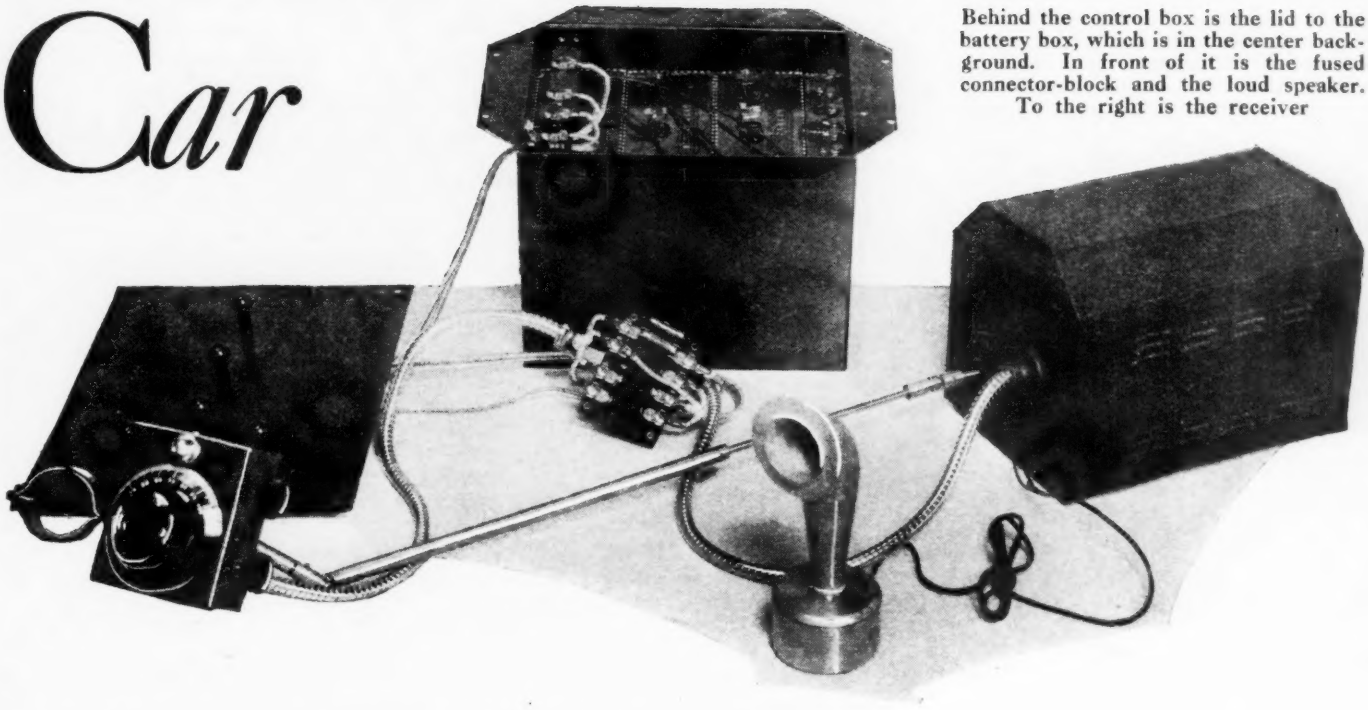
CERTAIN of us have long felt the need for a radio in the car. On those long jaunts, when the houses are few and far between, and the only sound is the purring of the motor as it covers fifty silent miles every hour, the solitary motorist feels as alone as a stranger in a big city. It is then that he wishes for a favorite tune or a familiar voice from his destination, growing louder and louder as he races toward it and promising rest and hospitality when he arrives.

Many have felt the desire so strongly that they have installed broadcast receivers in their cars. Many of these attempts have been failures, because the automobile presents special problems with which the home receiver cannot cope. For this reason it is necessary to start from the beginning in designing a set. The first move and most obvious requirement in any installation is proper shielding of the ignition system, if the radio is to be used while the car is in operation. To do this properly is a difficult and expensive job, as has been discovered only too well by the aircraft industry in their attempts to shield aviation motors in planes using radio equipment.

First of all, the plugs themselves must be shielded in such a fashion as to provide ample ventilation. Then all the high tension leads must be shielded, as well as the low tension leads and, in many cases, even the coil box itself. Ignition shielding is, therefore, hardly to be recommended for automobile use, and an attempt to subdue ignition noises without resorting to the costly and difficult-to-install shielding has resulted in the development of the resistor system of ignition noise suppression.

While this system does not entirely eliminate all radio frequency disturbances, it does materially reduce them, and has the advantage of being inexpensive and easily installed. The diagram in Fig. 2 gives all the necessary data, which consists mainly of inserting a 15,000 to 25,000 ohm fixed resistor in the high tension lead at the terminal of each spark plug and, in addition, a similar resistor in the common lead to the distributor head. This tends to localize the radio-frequency disturbances and damp out the oscillations quickly.

Car



Behind the control box is the lid to the battery box, which is in the center background. In front of it is the fused connector-block and the loud speaker. To the right is the receiver

An inside story of the National Receiver, together with some pointers on how to install a set in any car

Frequently it is also necessary to connect a small fixed condenser across the generator terminals to suppress noises due to brush sparking.

Perhaps the most satisfactory, but of course expensive, method of eliminating ignition troubles is that of employing a separate storage battery for the radio operation. Charging this battery, however, is an unmitigated nuisance. Should one desire to shield thoroughly the ignition system, the following notes may be of some assistance:

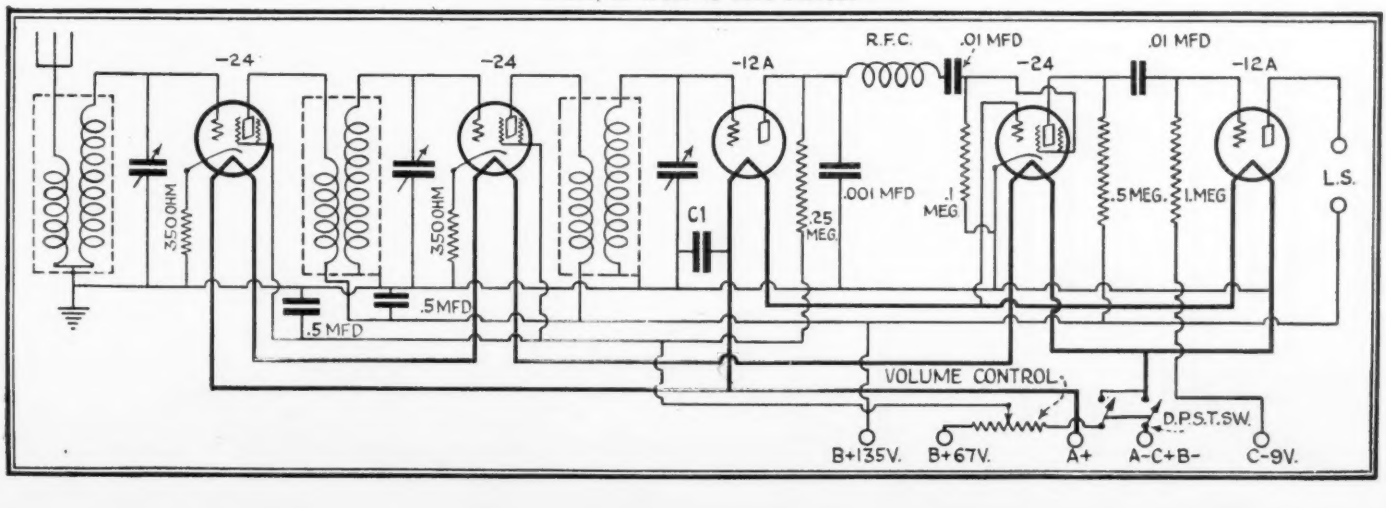
The shields about the spark plugs must be well ventilated. Fig. 1 shows one type of spark plug shield developed by the Walter Kidde Co., Inc., which should be applicable to automobile use. Any slight sparking about the plugs will generate ozone. This gas is a conductor, and if confined it will short-circuit the plug and cause the cylinder to misfire. The shield must be protected so that it cannot collect water, and it should be arranged to shed water to protect the plug if possible. Shielding for the wires usually consists of copper braid, such as is used for pig-tail connections, stretched over the outside of the leads. Copper tubing may be used provided it is watertight everywhere, or provided it has drain holes at every point where water might collect.

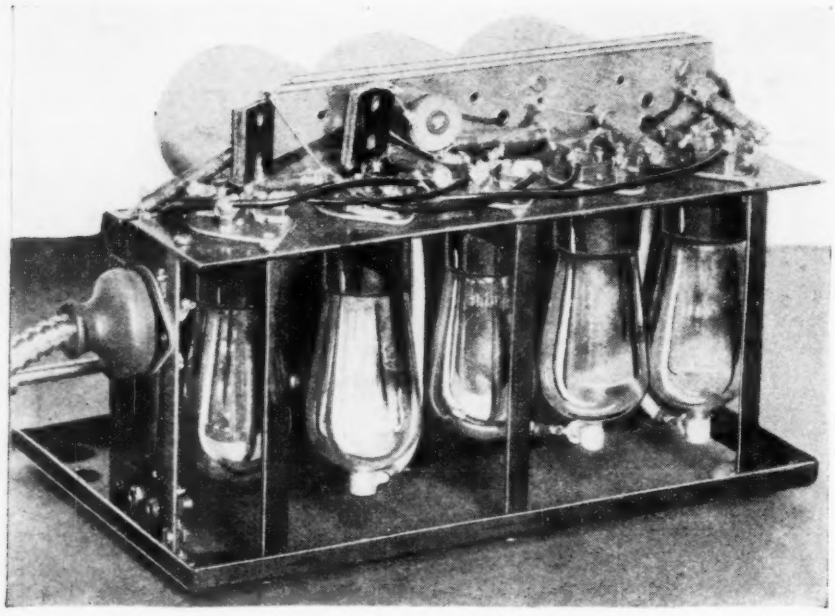
The radio set itself presents special problems. It must be sensitive, because of the poor antenna. In fact the effective height of an antenna as used in automobile radio is somewhere around three feet, due to the metal frame of the car being used as a ground, and as a result the pick-up is extremely poor. On the other hand, the audio output in milliwatts need not be so great, since the set will always be used in a small space. The radio end, in spite of its sensitivity, must be stable and easy to handle. These requirements alone would place quite a task on the radio engineer, even if they were not still further complicated by other considerations.

In order for the set to be kept stable, the tubes must not change their characteristics. If the storage battery of the car is used for the A supply, the filament voltage will vary from about five and one-half to eight or even ten volts, depending on the speed of the engine, condition of the battery and adjustment of the generator charging rate. This makes most d.c. tubes out of the question, and limits the designer to the use of a.c. tubes, a choice which is strengthened by the fact that d.c. tubes lack the necessary mechanical strength. Fortunately, the use of a.c. tubes does not place as heavy a drain on the battery as might be thought at first, because of their low-voltage rating which makes possible a series-parallel arrangement.

The number of tubes used must be limited, however, because we are working on the "over-rating" of the car battery, as its normal duties in supplying power to the lights, the starter and the ignition system are not reduced in any way by the addition of a radio installation.

Fig. 3—Schematic wiring diagram. The d.p.s.t. switch is required to open both the filament and B battery leads when the set is not in use, in order to save current





Side view of the Auto-Radio receiver, showing how compactly it is built

It must also be kept in mind that the plate supply is to be obtained from B batteries and not from the lamp socket. The a.c. set, with its elimination of batteries, has resulted in a complete disregard on the part of present-day set designers, for the amount of plate current consumed by some of their creations.

Fortunately, the screen grid tubes answer most of the problems by permitting sufficient radio-frequency gain to be obtained with two stages. For use in the output, the –12A has been found very satisfactory, although it is a d.c. tube. It has a heavy filament which is strong enough to stand the mechanical abuse. Since it is of the oxide coated type, it is not necessary to use a high filament temperature to get good emission. Consequently, it is possible to operate this tube in series with another –12A across the A supply, so as to further reduce the battery drain, this second tube being used as the detector.

The wiring diagram of an automobile receiver designed in the laboratory of the National Company is shown in Fig. 3. Just how the –12A tubes are used for both audio output and power detector is clearly shown in this diagram, as are also the two –24's in the radio-frequency amplifier.

A third –24 is used in the first audio stage, making a total of five tubes in all. Some explanation regarding the use of a screen-grid tube in the first audio stage may be in order. Due to the wide fluctuations in temperature and the stray fields present, it was felt that audio transformers were undesirable, even though a –27 could have just as well been used in place of the –24 to maintain an economical arrangement of the series-parallel A supply circuit. In order to get sufficient gain, the screen-grid tube was used as a space-charge amplifier giving a gain of about sixty. This arrangement has been proved not only very satisfactory but also quite economical, since the coupling condenser and resistor used are considerably less expensive than a transformer, and also take up much less room.

From the table it will be seen that about one-half of the present-day automobiles has the positive side of the A battery grounded, while the other half has the negative side grounded. Unfortunately this causes some complications. The filaments of the two –12A tubes are connected in series in such a way that the voltage drop in the filament of the output tube provides the grid bias for the power detector. Because of this arrangement, the tuned circuit preceding the detector must be completed through the by-pass condenser C1, shown in the circuit diagram. This condenser must be of the highest quality, with low losses and comparatively high capacity, or the stage will tune broadly. Consequently, it is necessary to change one connection, as indicated in the circuit diagram, depending on whether the positive or negative side of the battery, in the car in which the set is to be installed, is grounded.

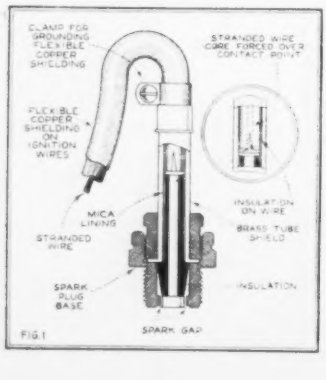
Volume control is obtained by varying the voltage on the screen grids of the radio-frequency tubes by means of a potentiometer. To prevent exhausting the battery when the set is not in use, a double-pole single-throw switch is used to interrupt both the A and B supply.

There are many ways in which the receiver controls may be mounted. Perhaps the simplest, and in many instances the most practical, is that of mounting them directly on the receiver case itself, and suspending the receiver behind the dash, out of the way, but located in such a manner that the controls may readily be reached.

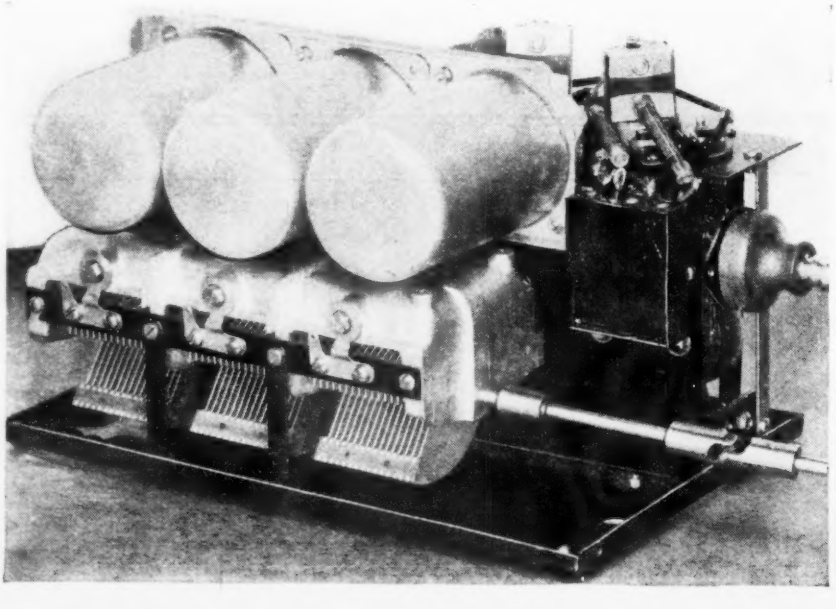
Another way is that of mounting the tuning dial, volume control and switch directly on the dash of the car, while a third system is the one illustrated, in which a small box is fastened to the steering column for supporting the remote- (*Continued on page* 853)

GUIDE TO "A" BATTERY CONNECTIONS

	Battery Terminal Grounded	
Name of Car	*Positive*	*Negative*
Buick		*
Cadillac	*	
Chevrolet		*
Essex		*
Ford	*	
Franklin	*	
Hudson		*
Hupmobile	*	
LaSalle	*	
Lincoln		*
Marmon	*	
Nash	*	
Oakland		*
Packard	*	
Pontiac		*
Studebaker	*	
Whippet		*
Willys-Knight		*



Side view, right, the radio frequency transformers are shielded within the cans. Left, shielding details for plugs and wires



Hum Control

Further Details Concerning the Miessner System of "Hum-Bucking" Which Has Not Only Made Possible Quiet Receiver Operation But a Reduction in List Prices As Well

By Benjamin F. Miessner

BEFORE beginning this, the second installment of my series of articles, I must unburden my soul with a confession. You, dear reader, have been led into a trap. If you saw that fearful-looking trap that Mr. Ronan pictured for you in the February number, all set for those terrible hum dragons, you now will know how it feels to get caught—that is, assuming you are caught. Whether or not you stay caught depends entirely on yourself.

Mr. Ronan, too, while he has not said so, or authorized me to say so, joins in my confession, for he, in fact, took the major part in this outrageous affair. Here we are with a false face of humor, hiding our serious scientific mien. We try to lead you into a dry desert of science with a shameless come-on of imitation of humor and low comedy. We knew full well that, sooner or later, the truth would come out and the criminal intent and malicious mischief in our hearts would be broadcast throughout the land. But we—that is, I (because Mr. Ronan, you see, cannot speak, but only gesture with his pen)—have decided to steal your thunder to beat you to it. We confess all, so there you are.

We are not going to get caught and face your accusing fingers. We mount the highest housetop and shout with all our might to warn you, if there still is time, that you will have to swallow this scientific toast dry—no butter, no coffee, nothing to cheer you along the dreary way. So be warned; turn back; extricate yourself from this wire and pursue more interesting game. Frankly, if hum, made interesting and palatable, is your quarry, seek elsewhere, for this is going to be a dud—a showy sizzle without the big noise you expected—an anticlimax. We are not going to play Perins and lead you into the thick of exciting battle with these awful demons of Mr. Ronan's fancy. This, no doubt, would be interesting if we were equal to it. Instead we (but I fear my gesticulating co-worker will now desert me) are going to play biologist and dissect our subjects, which, during the past five or ten years, have been rapidly succumbing to the fierce onslaughts of many bold warriors, and show you the secrets of their power, and the nature of our weapons and the strategy with which they were conquered. If you care to come along on this personally conducted tour of dissection and inspection, I shall be very happy to have you, and I may add that I shall try to make it as interesting as I can. Now I hope we understand one another.

My first article told you a little about hum in a.c. tubes. While I have an enormous mass of data on this subject, this material is more suited for publication in the proceedings of the technical societies, and therefore I will not burden you with it here. Besides, only a very small percentage of my readers could get any practical benefit from it because of the difficulties involved in making vacuum tubes. In connection with this subject of tubes and a.c. circuits generally, those who wish to make more than a superficial acquaintance with these subjects which I

IN this, the second of Mr. Miessner's articles, he describes in detail the salient features of his invention, which has proved a most important contribution to the radio industry. Many of the leading manufacturers, licensees under his patents, have been able to effect not only economies in production, but also to place on the market a more efficient receiver at lowered selling prices. One set manufacturer found it possible to eliminate eighteen pounds of apparatus from his product when the design was changed to incorporate the Miessner system.

The saving thus effected resulted in a vastly improved and much more efficient product, at lowered selling price to the public.

This article will be followed by others of equal interest and importance, in future issues of RADIO NEWS.

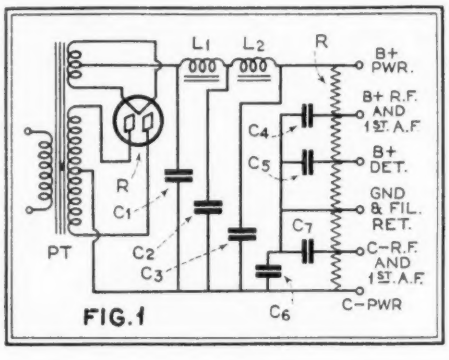


FIG. 1

A filter circuit of the "brute force" type generally used in the past

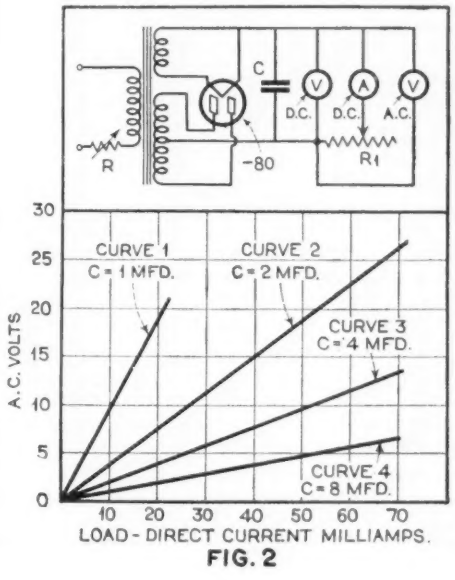


FIG. 2

Curves showing the variations of a.c. ripple in volts present across the load with 1, 2, 4 and 8 mfds. of condenser, respectively

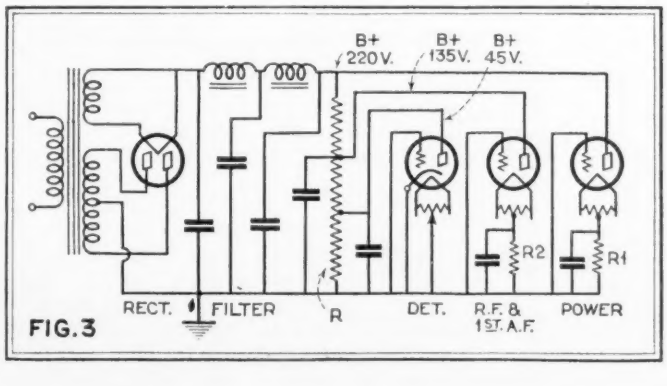


FIG. 3

The more modern arrangement for filtering

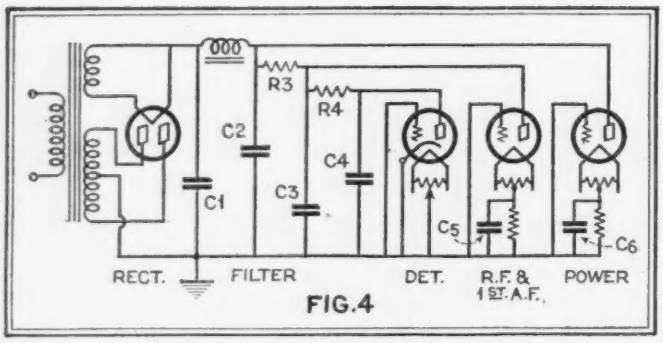


FIG.4

A still further improvement over that shown in Fig. 3

am giving you now, may possibly find some of my earlier scientific papers of interest. These are:

"A New System of Alternating Current Supply and its Application to a Commercial Broadcast Receiver," delivered before the Radio Club of America at Columbia University on September 22, 1926, and published first in the February and March, 1927, issues of *Radio Broadcast*, then in the "Proceedings of the Radio Club of America"; "A Three-Element A.C. Vacuum Tube," delivered before the Radio Club of America at Columbia University on May 18, 1927, and published in the September, 1927, issue of *Radio Broadcast*, and later in the "Proceedings of the Radio Club of America," and "Hum in All-Electric Radio Receivers," delivered at a joint meeting of the Institute of Radio Engineers, the American Institute of Electrical Engineers, and the Rochester Engineering Society, at Rochester, N. Y., on April 19, 1929. This was published in the January, 1930, number of the "Proceedings of the Institute of Radio Engineers."

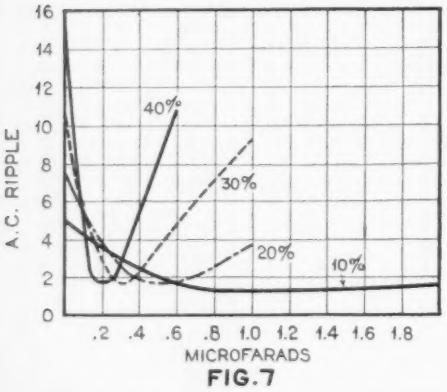


FIG.7

Curves of ripple measurements made with circuit shown in Fig. 6. The ordinates are arbitrary measures of ripple and the abscissæ are capacities of the variable condenser in tenths of a microfarad

It seems to me that some of the special circuit ararngements for reducing or eliminating hum, and the precautions necessary for avoiding certain types of hum are more appropriate—so we proceed withut further ado to them.

The filters generally used in the past few years have been chiefly of what is usually designated as the "brute force" type. They receive the rectified current and deliver to output terminals a substantially ripple-free direct current. Across the output terminals a voltage dividing resistance is connected, from which the various voltages of the receiver tubes are obtained by means of suitable taps. Such a system is shown in Fig. 1.

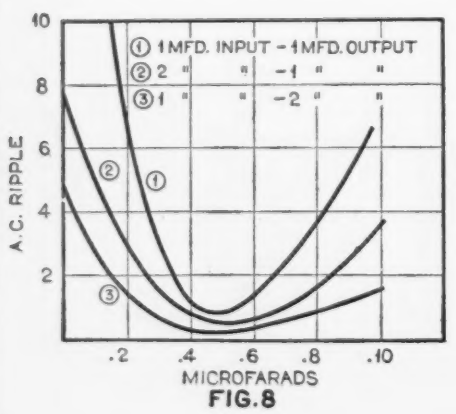


FIG.8

A family of curves indicating that the adjustment of the neutralizing condenser is not affected by change of input or output capacities

Here is shown the power transformer PT, full-wave rectifier tube R and the familiar two-stage filter, consisting of chokes L1 and L2 and condensers C1, C2 and C3. Across the filter output, that is, across C3, is connected the tap resistor R, from which the several "B" and "C" voltages are obtained for the receiver. The condensers C4, C5, C6 and C7 are provided more for signal by-passes, than for hum reduction. Without these, very strong inter-stage couplings in the receiver may result, causing motor-boating or other oscillations, or degenerative effects on the desired signal. This circuit is typical of the now obsolete "B-C" eliminators of several years ago, but is still to be found in a number of otherwise modern receivers. It requires, ordinarily, two large chokes and capacity to the total amount of 15 to 30 or more microfarads.

While such a circuit can be made quite effective, if sufficient inductance and capacity be used, it is an expensive and inefficient system. You will note that the current supply for the power tube is filtered just as well as that for the first audio, radio, or detector tubes, notwithstanding the fact that the detector tube plate ripple, for example, may be amplified as much as 500-fold into the plate or output circuit of the power tube. If the detector plate current is sufficiently filtered to prevent hum in the speaker connected to the power tube, after all of this amplification, then the plate current of the power tube, with no succeeding amplification, has been filtered 500 times too well.

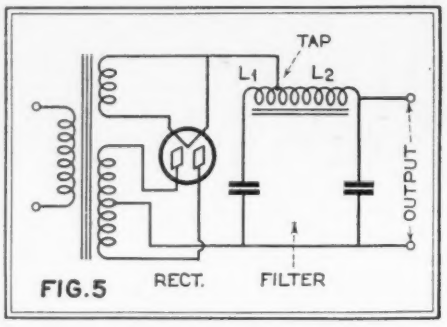


FIG.5

A Miessner "tapped-choke filter" for hum reduction makes possible considerably smaller values of filter elements

The logical arrangement, then, is to proportion the filtering for the different tubes in such a way that the current supply to any tube is no better than necessary. The power tube current requires relatively little filtering, the first audio and radio tubes more, and the detector tube most. That is to say, if the power tube hum will permit of a one per cent. plate ripple, that of the first audio must be reduced to the order of 4/100 of a per cent., and that of the detector to the order of 2/1000 of a per cent.

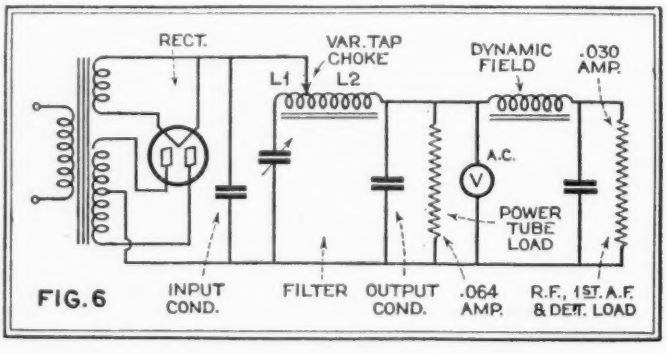
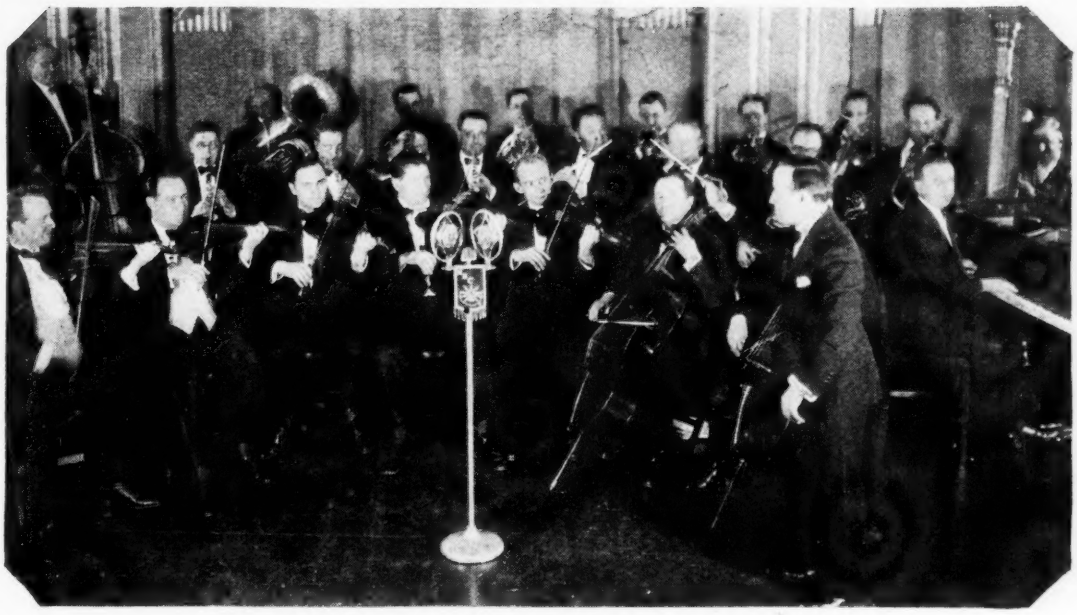


FIG.6

Circuit arrangement used for measuring filter ripple and from which the curves shown in Fig. 7 were made

Because of the possibility of interstage couplings in the receiver, due to portions of the voltage dividing resistance being included alike in grid and plate circuits of tubes, with large intervening amplification, the by-pass condensers shown must be rather large. This is especially important with respect to C6 and C7, the grid by-pass condensers, because the resistances across which they are bridged are small. (*Continued on page* 871)



Studio picture of Nat Shilkret and his orchestra broadcasting. Advertisers can profit by having such performances permanently recorded for their use

Canned Programs

Smaller Stations may now present excellent entertainment through the use of advertising recordings on wax discs

By Ted Nelson

IN its tremendous growth radio has followed many ramifications that are today as essential to its progress as the telephone wires have been to chain broadcasting.

For some time the smaller broadcasting stations have been hard hit because of the scarcity of good talent available to them in their respective localities. It is a known fact that high artistry eventually finds itself in large centers such as New York, Chicago, Hollywood, Los Angeles and other large cities where ability can be better capitalized. If, perchance, a good artist is developed in a small town, he immediately seeks capital or uses his savings to get to the larger center for greater opportunities. The majority eventually land in New York. This naturally leaves hundreds of other cities with more or less inferior and limited talent, so that a broadcast station can scarcely keep going a full day without repeating similar programs or shutting down for certain periods. This is undesirable as it does not give the listeners a complete service.

A good part of this problem was solved when the chains came into existence; but these also served a limited number of cities and a limited number of stations. From the standpoint of the stations themselves, other means for circumventing the problem of entertainment were necessary, since the income of a station is limited when it is operating on a chain.

As a solution phonograph records were brought into use. The stations resorted to the use of records which could be purchased in the phonograph stores and the radio audience listened to excellent programs without knowing whether or not it was a phonograph record that was being broadcast.

But, the Federal Radio Commission strenuously objected to this practice. A further objection to this type of program was voiced by many listeners, because anyone could purchase these records and play them in his own home.

Then the writer evolved the idea (*Continued on page* 851)

There is a similarity between all disc recording machines. Photo shows the type used in making talking movies. Two are used alternately during recording, with overlaps on their records to permit fading one into the other in reproduction

Television

New type of scanning disc make it adaptable to any in use.

By Kenneth

TELEVISION development has been given new impetus by the invention of another type of scanning disc for use in receiving sets, the first account of which appeared recently in the Chicago *Daily News*.

The new disc is one of the most flexible that thus far has been developed, in that it can be adapted to any known system of scanning that is in use at the present time in experimental work.

It operates on the principle of reflecting light to the screen instead of projecting it through holes in the disc—a principle which in itself is not new, although the method by which the effect is obtained is original with the inventor, Arthur H. Watson, who heads the Watson Television Laboratories of Chicago.

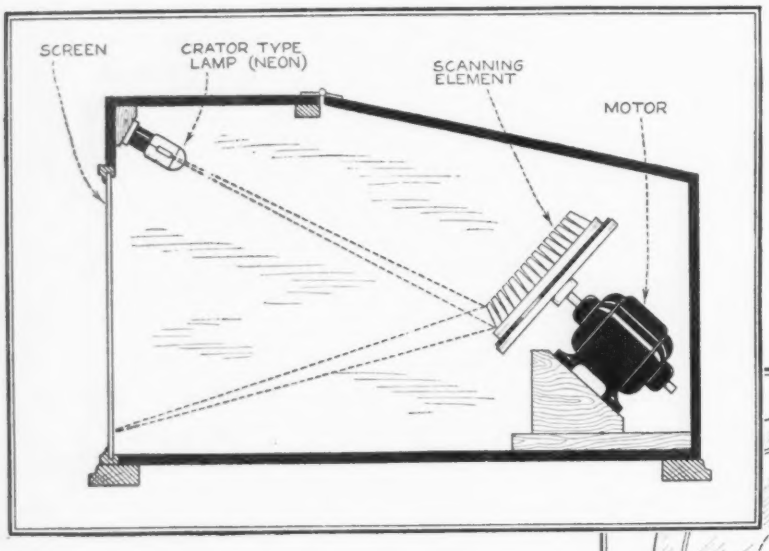
The design lends itself to manufacture with ease, since there are no adjustments to be made once the disc has been assembled. The reflecting surface is made of highly-polished Monel metal. Although several types of reflectors have been tried nothing better has been found. The metal was well known during the war when it was used to make unbreakable mirrors for the troops. As applied to the television disc, Monel metal has the property of retaining luster, and it can be bent to fairly sharp angles without injury. Reference to the illustrations will show that the segments of the disc protrude at an angle nearing that of ninety degrees.

The complete disc is about seven inches in diameter, a qualification that permits the use of a comparatively small receiving unit. Aside from the screws that are used to hold the assembly together, the disc can be made of four parts: the Monel disc, and a base ring which carries the bearing, and to which is attached a ring molded in such a way that each of the segments on the metal disc will be given a definite angle. In order that the segments will be held rigidly in position a complementary ring is fastened to the base, and as it is clamped into position each of the segments takes the proper angle as determined from the experiments conducted in the laboratory.

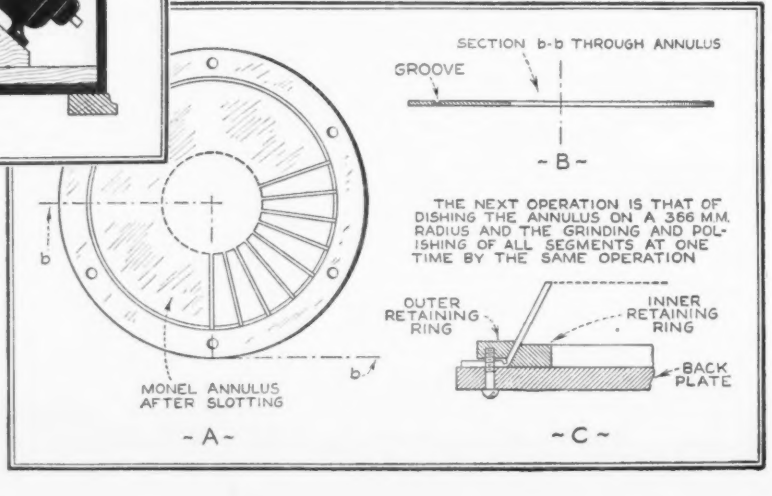
The mounting of the disc is determined by the method used by the station transmitting the television impulses. Although attempts have been made to standardize the television branch of the radio industry, there seems to be no logical way in which the methods can be entirely standardized at the present time. Therefore, we find that different laboratories scan the image horizontally or vertically. In most of the methods the scanning line describes an arc, although the position of the arc differs. The ends of the segment may be at the top or the bottom. Regardless of the position, the Watson disc can be changed to conform to the transmitting system by merely varying the angle at which the disc is mounted.

The size of the scanning element employed is seven inches in diameter overall and one and three-quarters inches in depth. The picture produced with this element, with the screen at a distance of fourteen inches, is as large in area as the scanning element itself, measuring approximately five by six inches. No lenses or optical reflection or refraction devices are used other than the segmental elements of the scanning device itself. An entire receiver may be housed within a cabinet nine inches wide, fifteen inches high and eighteen inches in length.

Fig. 3 shows the scanning element, consisting of an annulus of Monel metal, and having inwardly extending radial slots separating the annulus at its inner periphery into as many segments as there shall be lines to the picture. This annulus is then cupped to a curvature on a radius of substantially 366 millimeters, and its concave face subjected to a single



Above: Cross-sectional view of the Watson television receiver, showing how the mirrors on the rotating scanning disc reflect light from the crator type neon lamp to the screen, which may be five by six inches square



Right: Details of the scanning disc, showing how the reflecting mirrors of highly polished Monel metal are bent to the proper angle

Forges Ahead

embodies features which transmitting system now

A. Hathaway

Photo © The Chicago Daily News

Arthur H. Watson holding the new scanning disc which he invented and which may hasten the time when television will be available to everyone

grinding and polishing operation, thus producing forty-eight perfect and identical optically correct focusing reflectors.

Next, the segments are struck upwardly by die to an angle of substantially forty-five degrees from the axis of rotation, being the central axis of the annulus. The annulus thus prepared is mounted upon a bakelite mounting disc, and by the use of a pair of complementary retaining rings the annulus is drawn tightly in engagement with the disc. Constantly changing inclination on the opposed surface of the retaining rings securely locks the segments to their proper adjusted and operable positions so that the optical axes of the segments diverge outwardly, each adjoining axis slightly higher or lower as the case may be. A lamp of the crator type is placed so that the image of its incandescent gaseous part is projected upon the screen S, and when the scanning annulus is rotated a succession of parallel lines traverses the screen.

This system of scanning differs from any of the present known scanning systems, in that the exact shape and size of the spot traversing the screen is determined with great accuracy by the use of a mask associated with the lamp. Formerly a scanning spot of peculiar shape devised as most efficient could be obtained only through the use of a special die for stamping the holes in the spiral disc, which might be expected to result in difficulties arising through the wearing of the die, not to mention the high cost of the apparatus necessary for construction.

The complete televisor comprises but four parts, the lamp, the drum, a motor for driving the drum and a screen.

The problem of synchronization is taken care of in metropolitan areas by using a synchronous motor, and swinging the entire motor and drum along the axis of the drum to adjust for phase position between the poles of the motor, the major adjustment being carried out by momentarily breaking the motor circuit, permitting lag to take place. For intra-area reception a variable speed motor may be employed.

During the months in which Mr. Watson has been developing his disc he has tried other types of reflecting material. Nickel-plating was one of the methods tried, but nickel-plating fails to hold its luster when exposed to the atmosphere and requires frequent polishing.

The extensive use of chromium plating appeared to present another possibility, but it was discarded when it was found that imperfections in the metal would show through the plating in the form of pockmarks. The marks would not be apparent to the eye, but when the light was reflected upon the screen they were very much in evidence. Using chromium plating over a layer of nickel failed to serve the purpose, for the imperfections in the surface of the metal were made evident through the double plating.

Accordingly, the inventor reverted to Monel metal, which reflects with nearly the same efficiency as silvered glass. At the same time the metal is lighter and more serviceable.

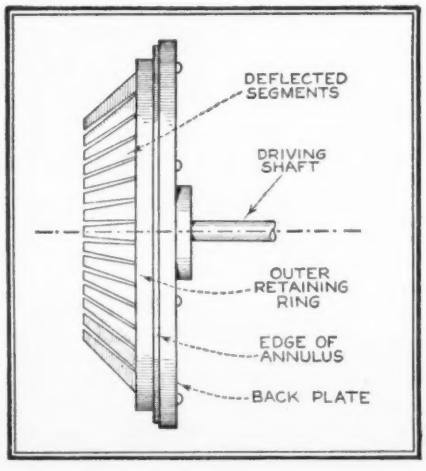
Salient Features of the Watson System

Pictures five by six inches may be produced directly on the screen without any intervening means for the purpose of magnification.

It may be instantly adapted to any type of television scanning systems in use today, an advantage not possessed by any other known system.

No lenses or optical reflection or refraction devices are used other than the highly polished reflecting elements of the disc itself.

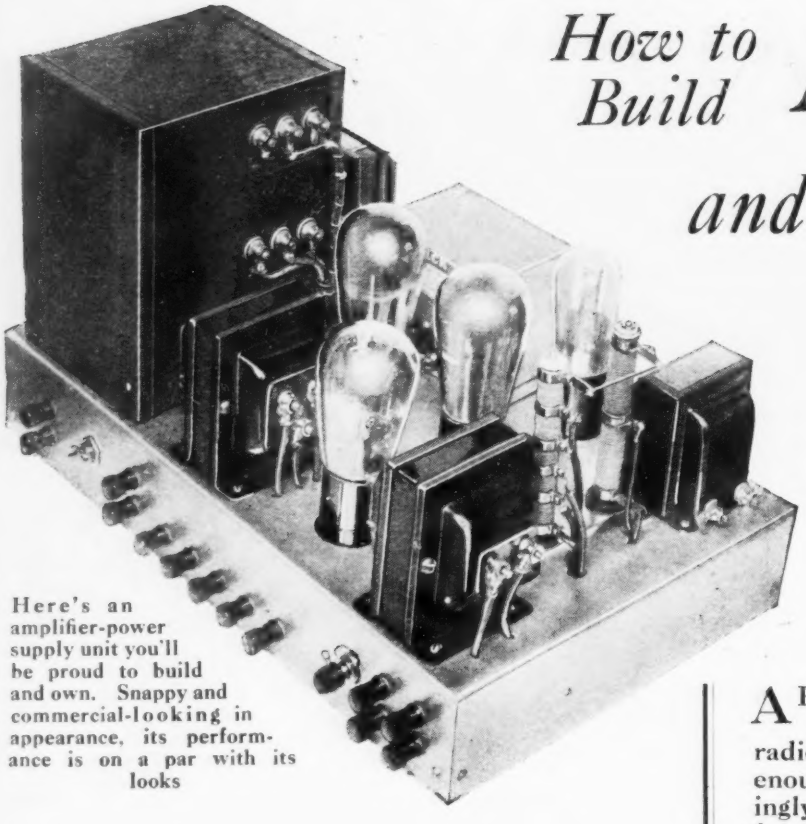
An entire receiving machine may be housed within a cabinet nine inches wide, fifteen inches high and eighteen inches in length, and these proportions may be still further reduced if desired.



Side view of the scanning disc, showing its assembly of the rings and Monel metal mirror segments

How to Build A Universal *and* Power

Complete Details for Pull Amplifier and B May Be Used With or for Speech



Here's an amplifier-power supply unit you'll be proud to build and own. Snappy and commercial-looking in appearance, its performance is on a par with its looks

AFTER all, what we really strive for in the design and construction of a radio receiver is good tone quality and enough volume to fill our living room pleasingly, with, of course, a reserve of volume for special occasions. Tuners can be sensitive, and they can be selective, but if what they receive is hopelessly garbled by a poorly designed, overloaded and distorting audio amplifier, all our work goes for naught.

It behooves us then to be doubly certain that, to begin with, our receiver is furnished with an audio amplifier which will faithfully reproduce the sounds originating before the microphone in the broadcasting studio.

GENERALLY speaking, the design and construction of a radio receiver are accomplished in one of two ways. Either the receiver is designed and constructed as a whole; that is, the tuner and audio channels are built as one unit, or the tuner is built as a separate unit and the audio amplifier is built as a separate unit. Let us consider that for the time being we are dealing with the second of these two classes, and that it is necessary to build an audio amplifier and power supply device for a tuner unit which has already been constructed.

Usually there are a number of considerations which must be taken into account before we can begin with the actual construction of a suitable audio amplifier. First, there is the matter of choosing the number of stages of amplification which we wish to employ. Second, the type of tubes which we shall use. Third, questions will arise as to whether the amplifier is to be used purely as an audio channel for the tuner unit already built, or whether it is to have such features incorporated in its design as will allow it to be used for the production of phonograph music. Going back to the matter of tubes, not only must we describe the type of tube which is to be used in the first stage of audio frequency amplification, but we must also decide whether the final audio stage is to be of a push-pull type or use straight audio-frequency amplification. If it is to be of the push-pull type (since for the sake of quality reproduction this is more desirable) then we will have to decide what kind of tubes we are to use in this stage. The design and construction of the power supply unit which is to go with the audio amplifier will hinge directly on the choice of the type of tubes used in the push-pull arrangement. For instance, if we decide to use a pair of –71A's in the push-pull amplifier, then the voltage requirements from the power supply unit will be of one kind, whereas if we decide to use a pair of –45 or –50 tubes, the voltage requirements from the power supply unit will be entirely different. In the matter of the use of –50 tubes in the push-pull amplifier, the differences in the design of the power unit will be very great. For example not only will we have to use filter condensers having a higher working voltage, but also the rectifier itself will have to be of a huskier type than that used in the –71 power supply. For the –71A all we require is a type –80 tube, used in a full wave circuit. In the –50 amplifier the –80 tube will not supply us with the required output voltages, and therefore it will be necessary to use the –81 in a half-wave rectifier circuit, with its attendant higher output or greater handling capacity, or a pair of –81's arranged in full-wave rectifier circuit to obtain the desired voltage output.

The question will confront the designer as to whether he should use the type –26 tube in the first audio-frequency stage of amplification or whether he should use the type –27 tube. The type –27 is used quite generally as the first-stage amplifier, because of the fact that it functions with less noticeable hum in the output than does the type –26.

The physical features of the amplifier must receive their share of attention, too. The compactness of the unit, the layout of the parts in a symmetrical arrangement, the location of the parts to make wiring easy—all these are features which must be taken into consideration before any actual work is begun. Where a power supply unit is combined with the audio channel the question becomes of greater importance, since precautions must be taken to prevent the transformers, chokes, etc., of the power unit from interacting with the audio amplifier parts and producing distortion.

Keeping all these points in mind, an amplifier-power supply unit has been built in the laboratory of RADIO NEWS which can be used with any existing tuner unit, or any which can be used with a good electric pick-up for the reproduction of phonograph music.

Standard Amplifier Circuit Used

In Fig. 1 is shown the circuit diagram which is used in the amplifier-power supply unit described here.

It will be seen from the circuit that two stages of audio-frequency amplification are employed in the audio channel. The final audio stage consists of a pair of –45 tubes arranged in push-pull. In the first stage a type –27 tube is employed. T1 shows the line transformer which is used to supply not only the high voltage to the plates of the rectifier tube, but also the filament voltage to the rectifier and the pair of –45's. A

Audio Amplifier *Supply*

Assembling a 245 Push-Supply Unit Which Phonograph or Radio Amplifiers.

By John B. Brennan, Jr.

A ruggedly built chassis holds all of the transformer and filter condensers on its topside, while underneath are mounted bias resistors and bypass condensers. Above is a rear view of the chassis

separate transformer, T5, is employed to furnish the filament voltage to the –27 tube in the first audio stage, and also to the a.c. tubes which may be employed in the tuner unit. T2, T3 and T4 are standard audio-frequency amplifying transformers and for the specific type which should be employed the reader is referred to the parts list. The transformer T4 is employed to couple the –45 tubes to the loud speaker, and its type will depend upon the type of loud speaker used—dynamic or magnetic.

C bias for the first stage of audio-frequency amplification is obtained by a voltage drop through the resistor R2. The condenser C5 and the resistor R3 provide a filter return path to the heater or cathode of the tube. Grid bias for the two push-pull amplifier tubes is obtained by a voltage drop through the lower section of the resistance divider R1. R4 and C4 provide the filter for the C bias circuit of the push-pull amplifier. Note that for a center-tap arrangement on the push-pull tubes a center-tap resistor, R4, is employed, rather than a connection to the mid-point of the filament winding which supplies the filament voltage to these tubes.

The Power Unit

In the power supply unit the filter section consists of a bank of condensers and two chokes. The condenser section consists of three condensers, one of 2 mfd. and the other two of 4 mfd. The two chokes are integral parts of the power transformer assembly—that is, the transformer and the two chokes come as one unit, the chokes being assembled within the can that also houses the transformer. A block of five condensers, each of 1 mfd. apiece, is used for connection across the various terminals in the voltage divider output circuit. These condensers are shown as C2 in the drawing. The output voltage divider, R1, is arranged with taps to provide a B minus, a B+45, a B+90, a B+135, and a B+180 volt output in addition to the regular terminal for the total voltage output from the filter circuit for the plates of the two –45 tubes.

A line switch for breaking the 110-volt supply to the filament and line transformers is mounted on the side of the amplifier chassis, but may be removed from this position and, by means of an extension cord, mounted on the panel of the tuner unit with which the amplifier is to be used. A single-pole double-throw jack switch, also mounted on the side of the chassis, allows quick changeover from radio to phonograph reproduction. This switch, too, may be mounted on the receiver panel for convenience.

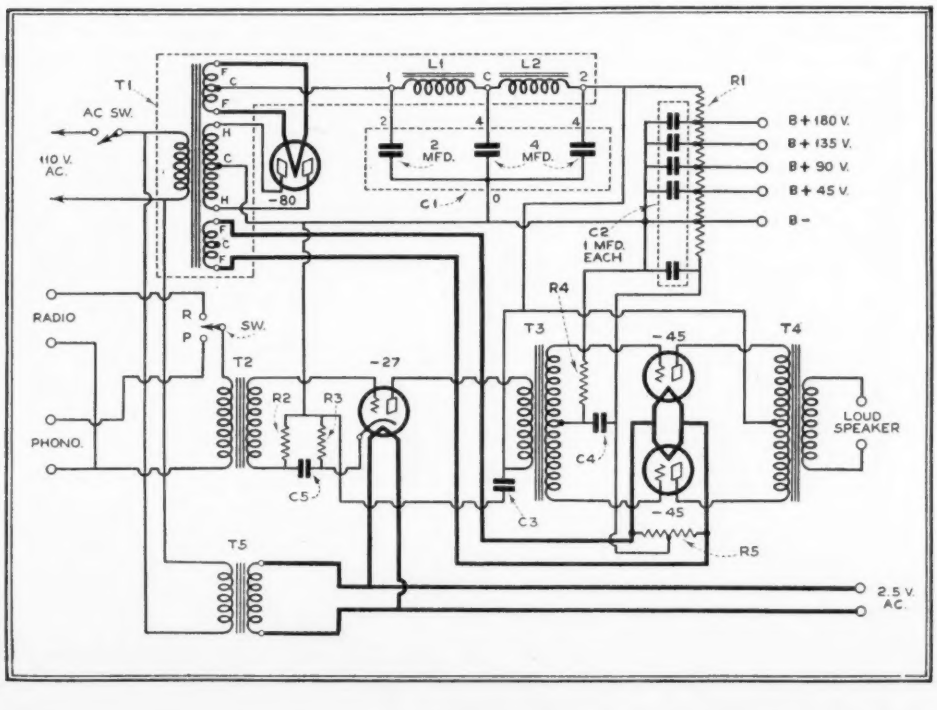


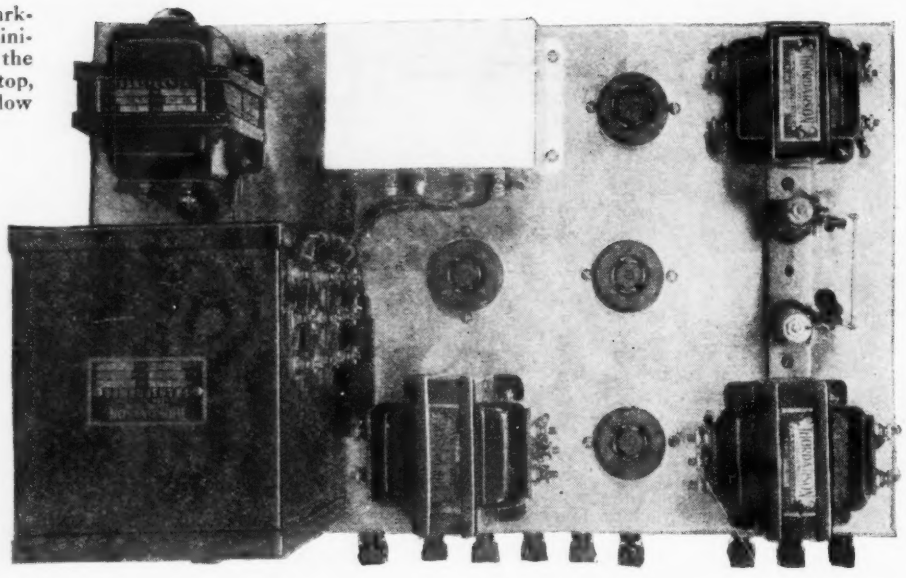
Fig. 1—The circuit diagram of the –45 amplifier-power supply unit may be considered as consisting of three distinct units, namely: the power supply (at the top), the audio channel (center) and the filament supply (bottom). The parts employed, as identified by the symbols, are enumerated in the Parts List

Constructional Details

The chassis on which the amplifier-power supply parts are mounted is fashioned from a sheet of aluminum of about ⅛" thickness. Specifications for the sizing and cutting of this material are shown in Fig. 3. This figure shows too how the corners are permanently fastened together so as to provide a sound, solid foundation for the units which are to be mounted on it—units of considerable weight.

Once the chassis has been formed, the holes for mounting the various pieces of apparatus may be drilled, following the layout given in Fig. 2.

It is well to study the several photographs which accompany this article so that a thorough understanding as to

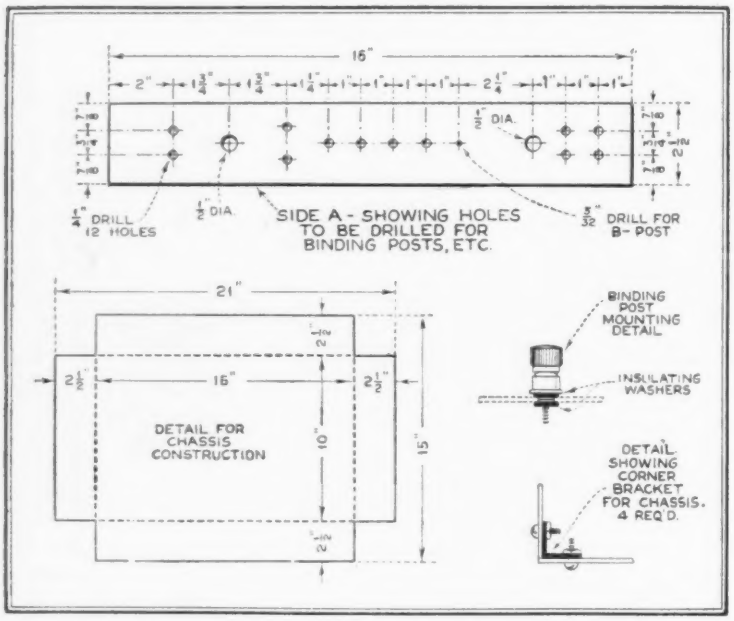


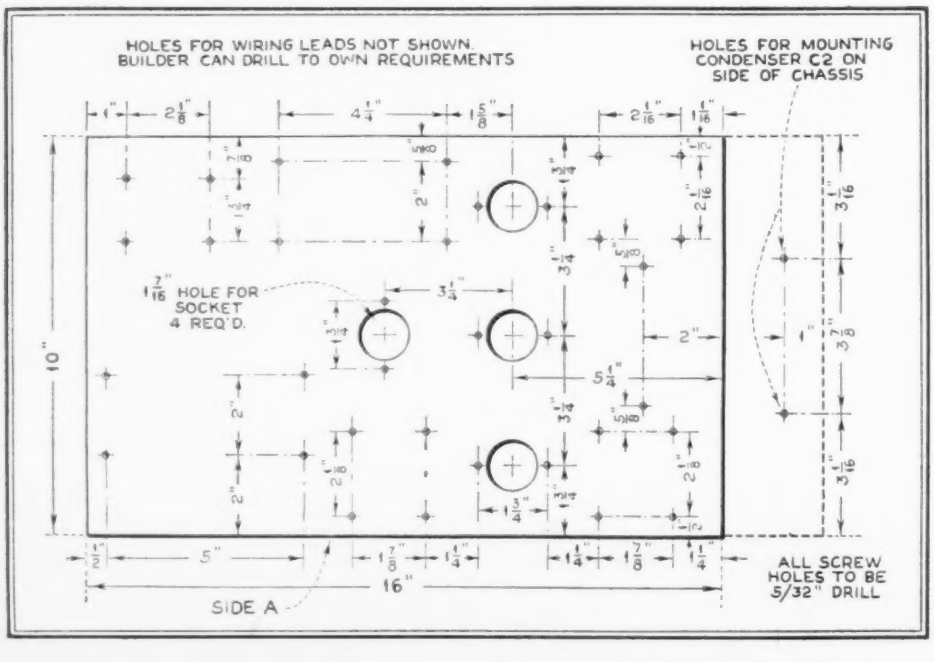
The top view of the device presents a remarkably clean-looking appearance, with a minimum of exposed wires visible. Most of the connecting leads are below the chassis top, holes being drilled through the top to allow their passage

the location and placement of each part is obtained.

Such parts as are to be mounted on the top of the chassis should be placed in position temporarily, and the placement of wiring holes spotted and drilled on the surface, so that wires from these parts may be run through to the under side for connection to apparatus located there. This procedure is recommended since it is much easier to drill these holes from spotted positions, with the parts removed, than when the apparatus is mounted and fastened in place.

Insulated washers should be used, front and back, on the side-strip which holds the binding posts. The drilling details for this terminal layout are shown in Fig. 3. Note that only the hole which takes the B— post is drilled—just large enough to take the threaded portion of the binding post. All the others are of larger size so that with the aid of the insulated washers, the shank of the binding post will be kept accurately centered to prevent "shorting" between the posts and the chassis. Some constructors may wish to take added precautions against short circuiting here by cutting away that section of the chassis' side, and mounting over it a strip of bakelite or other insulating material which will hold the binding posts.





Wiring

The schematic circuit of the amplifier-power supply unit as shown in Fig. 1 and the picture wiring diagram, Fig. 4, will show quite clearly how the various parts are connected. The picture diagram, Fig. 4, shows each part in its relative position, whether it be mounted on top or underneath the chassis.

Where one is dealing with rather heavy currents and high voltages, as in this device, it is well in wiring to be sure that a good grade of wire with the proper kind of insulation is used.

A stranded rubber-covered or paraffined-tubing flexible wire, each strand being tinned, should be used for connecting the different parts together.

In wiring the Electrad –45 Voltage Divider unit into the circuit, care should be exercised to make sure that connections are made to the proper terminals on the two upright resistance units. Here you will have to refer carefully to the circuit diagram, Fig. 1. The high voltage end, coming from the choke L2 (terminal 2) connects to the lower contact terminal on the resistor unit having the six contact tabs. The plate voltages for a tuner unit, which might be used with the amplifier-power supply, are brought out in regular order, the higher values of voltages beginning at the bottom and progressing upward. The B— terminal is that located in the center of the second resistance unit, while the C bias tap for the two –45 tubes is located at the bottom of this unit.

Leads which carry raw a.c., such as those to and from the line and filament transformers, should be twisted to minimize the production of hum.

Adjustments

There are no manual controls on the amplifier-power supply unit, other than the a.c. line switch and the phono-radio switch. Once the unit is wired it is ready for operation.

Fig. 2 (left) and Fig. 3 (left, above)—In Fig. 2 are shown the drilling details and location holes for mounting the parts above and underneath the chassis. Fig. 3 shows the constructional details for fashioning the chassis, and also the layout of the holes for the terminal strip

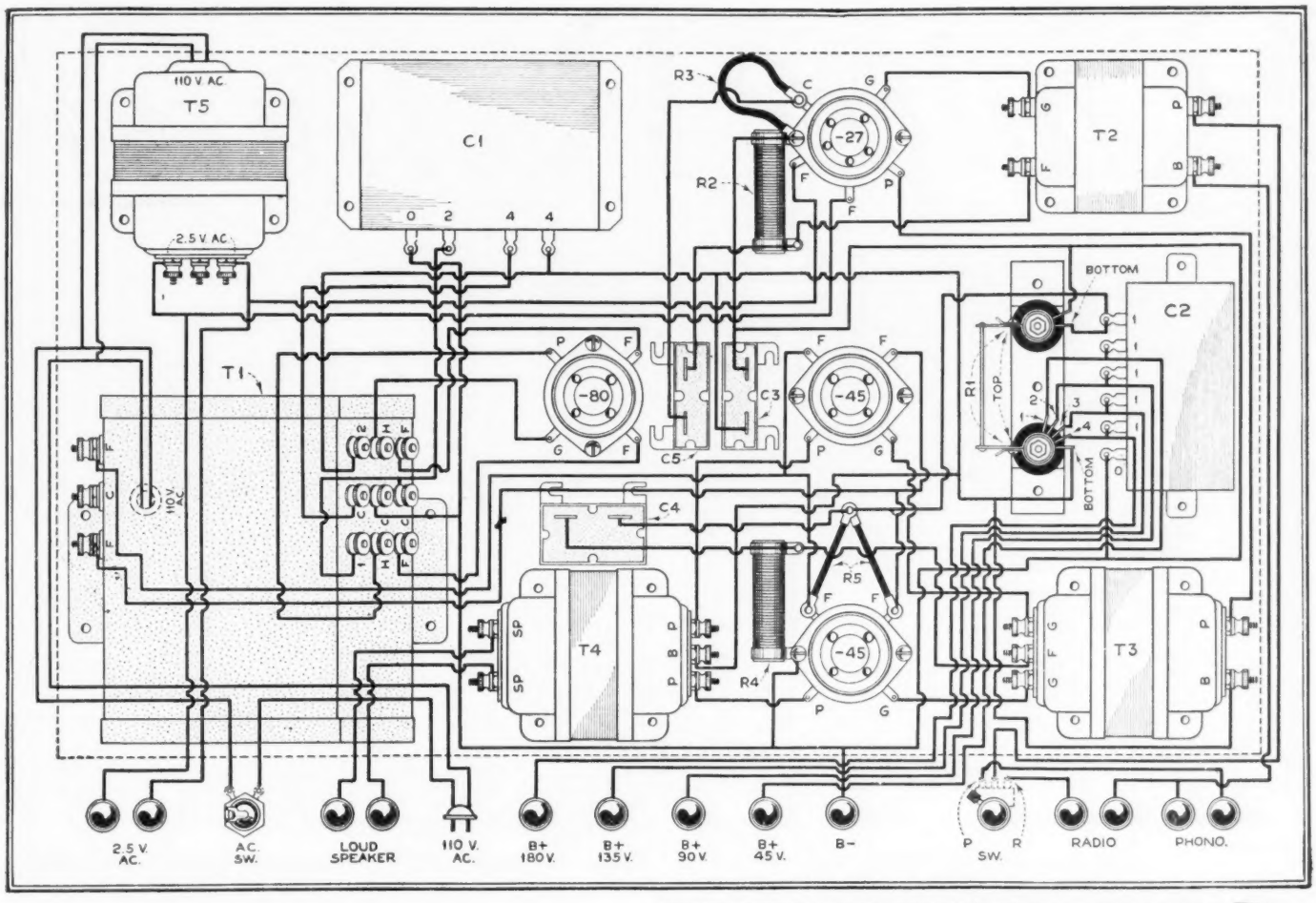
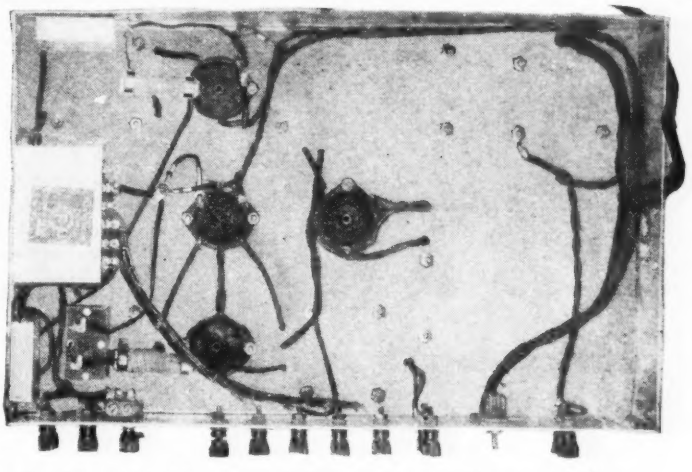


Fig. 4—Wiring an amplifier or a receiver from a picture wiring diagram is much easier, but not as instructive, as wiring from a schematic circuit diagram. In the picture diagram, shown above, each part is relatively in the position it will occupy in the finished job

Depending on the tuner which is used with it, the voltage supply taps on the many-tapped voltage divider resistor may have to be loosened and readjusted so as to obtain the correct values of plate voltage. Such adjustments should be made while the tuner actually is in operation—that is, while it is providing a "load" to the supply unit. If no high-resistance voltmeter is available for obtaining accurate adjustments, the constructor will have to rely on his sense of hearing, adjusting the taps until reception is obtained most clearly and distinctly.

Parts List

T1—Thordarson power compact, type R245 (houses chokes L1 and L2)
T2—Thordarson audio transformers, type R300
T3—Thordarson input push-pull audio transformer, type 2922
T4—Thordarson output push-pull audio transformer, type 2903
T5—Thordarson filament transformer, type T3660
C1—Flechtheim "B" condenser block, type HV 244, total of 10 mfd.
C2—Flechtheim by-pass condenser block (450-volt test), total of 5 mfd.
C4, C5—Flechtheim by-pass condensers, 1 mfd. each.
C4—Flechtheim by-pass condenser, 2 mfd.
R1—Electrad truvolt resistance bank, type C245 B2 (14,700 ohms)
R2, R4—Electrad truvolt fixed resistors, type B500 (50,000 ohms)
R3—Electrad truvolt wire grid resistor, 2,000 ohms
R5—Electrad truvolt type V, center tap, V20, 20 ohms
Four Eby sockets (3 four-prong and 1 five-prong)
One line switch (toggle)
One Yaxley phono-radio switch
Eleven Eby binding posts
Two boxes Corwico stranded braidite
Chassis material (sheet aluminum as per Fig. 3)



In this underside view of the chassis note how, with few exceptions, the wires are twisted or cabled. Where joints between wires are made, the resulting connection is well insulated with friction tape

Audio-frequency amplifiers are becoming of increasing importance and no longer are considered merely as part of a well-designed radio receiver.

Servicemen, experimenters and custom set builders have found that it is to their financial benefit to turn their knowledge into money-making endeavors.

Revamping old-time phonographs by installing a good quality audio channel with a satisfactory magnetic pick-up has proved especially lucrative.

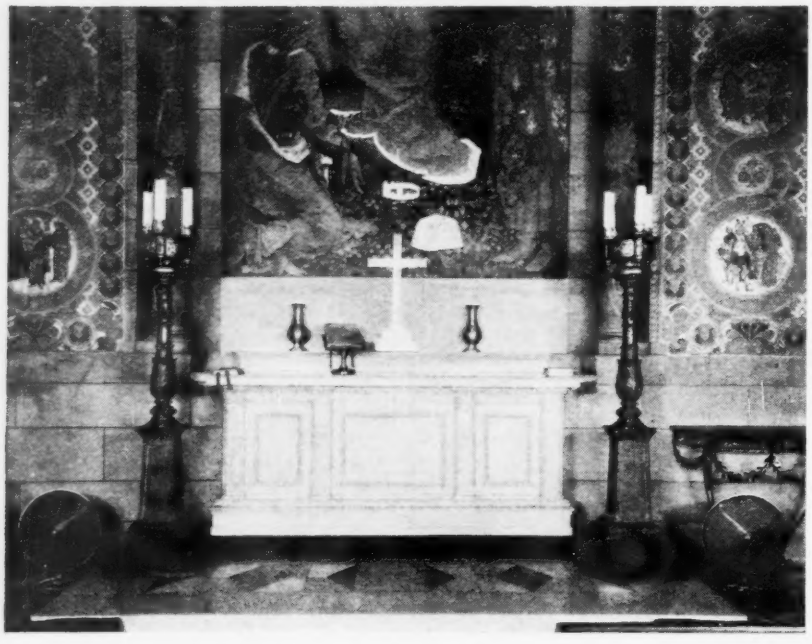
And now, with the advent of the home talkies, an added importance is given to the pick-up and amplifier to provide ear entertainment simultaneous with eye entertainment.

A series of articles in past issues of RADIO NEWS on speech amplifiers has clearly demonstrated the virtually virgin field which exists in supplying restaurants, motion picture houses, department stores, entertainment and dance halls and the like with speech and sound amplifiers.

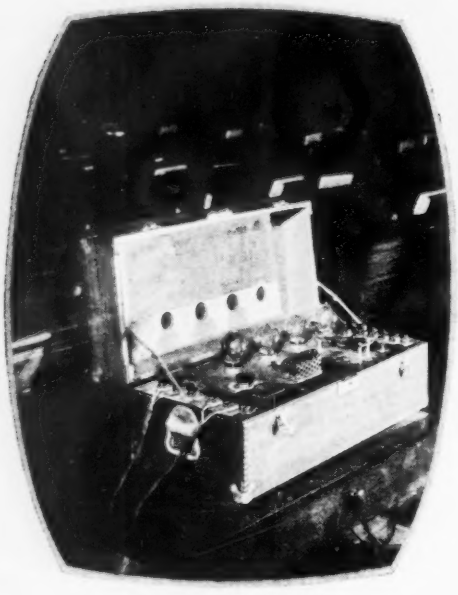
He is slow indeed who sees only an addition to his radio in the building of an audio amplifier power supply unit such as that described here.

Radio Religion

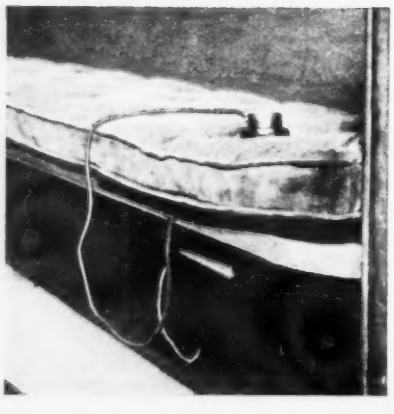
By
S. Gordon Taylor



(Above) The chapel of St. Bartholomew's Church in New York City is used when the main auditorium is filled



(Left) A small Western Electric amplifier which is capable of supplying three distinct services: loud speakers above the chancel, reproducers in the chapel and headphones for the deaf



An out-of-the-way volume control and headphone installed in pews to make sermons available to the deaf

Photographs Courtesy of Amplifier Service Co., N. Y.

IN the August issue of RADIO NEWS, which contained the first article of this series on amplifiers, a statement was made indicating the potential size of the market for power amplifiers and radio receivers outside of the home. It was stated that in the United States there are 26,000 hotels, 73,000 hospitals and 263,000 school buildings, in addition to innumerable restaurants, stores and assembly places, all of which are potential prospects for the sale of sound amplifiers and radio equipment. There was some comment at the time as to the logic of considering all of these existing projects as potential future users of amplifier systems.

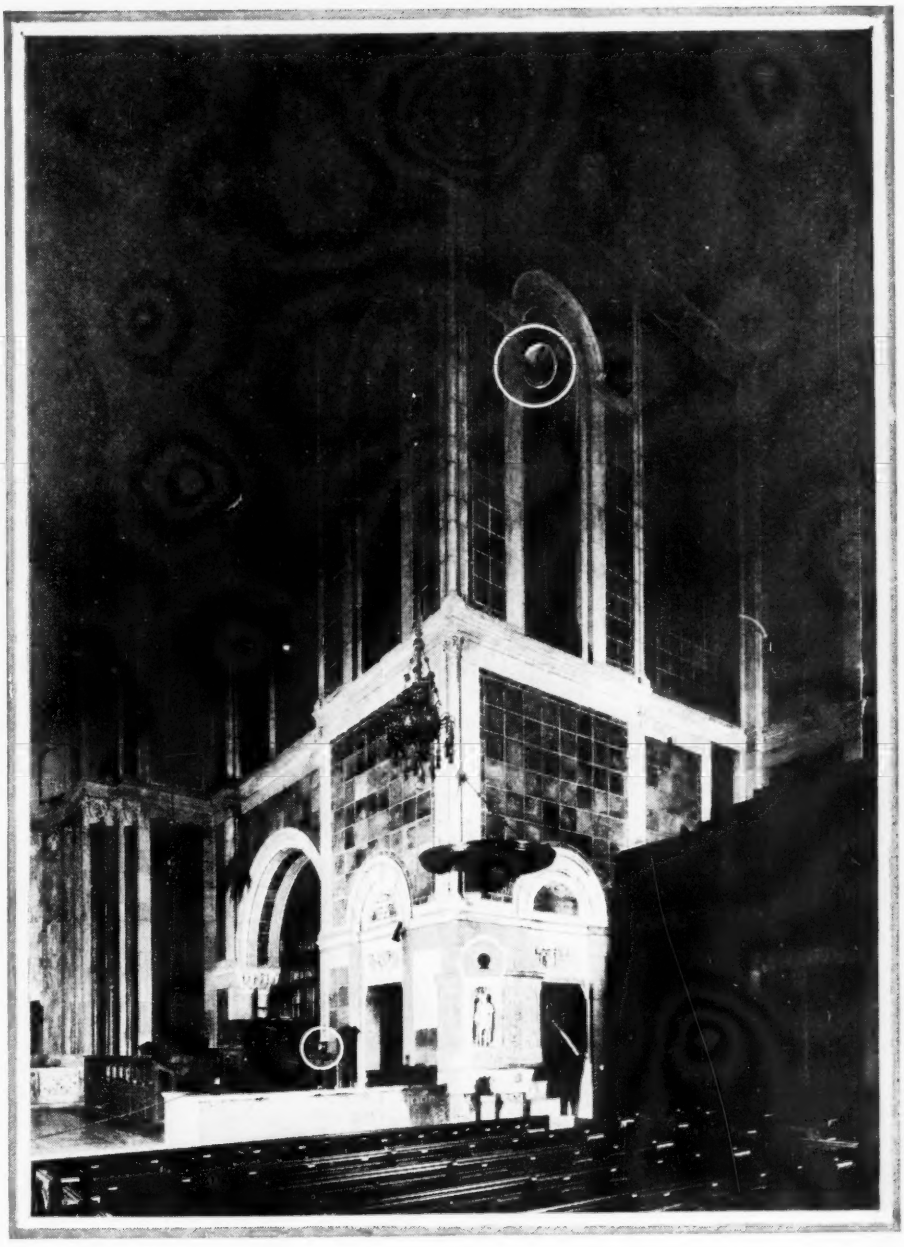
In compiling this list, it was with the conviction that while all would not ultimately install amplifiers, the great majority of them would, not in a year or two perhaps, but certainly in the not far distant future. Weight has recently been added to this conviction, as far as schools are concerned, by plans which the United States Bureau of Education now has on foot for a thorough investigation of the possibilities of radio and amplifiers in educational work, looking toward the cooperative organization of broadcast stations and the schools, so that regular educational program periods may be broadcast and thus made available to schools. The survey is still in progress and it is too early to expect concrete plans. However, these plans will be worked out within the next few months, and in all probability will result in radio being adopted as a regular feature of the school curriculum.

It is not a difficult matter to picture the superior effectiveness of broadcast programs over school books in so far as certain subjects are concerned. For instance, a radio dramatization of Columbus landing in America would assume much more realistic proportions to the average child than would a written description of the same episode. This does not by any means indicate that the school teacher will be eliminated, but it does provide an undoubted opportunity as an aid in their conducting of the regular instruction courses.

To the amplifier installation man this subject is one of the greatest importance, because with the establishment throughout the country of a regular schedule of broadcast programs of interest to schools, radio and amplifier systems will become practically an essential feature of school equipment and a tremendous market will be opened up. It is the intention to provide complete reports in RADIO NEWS on the progress of the educational survey undertaken by the Government, in order that those interested in installation work will be kept posted.

The church is another logical outlet for amplifier equipment. And amplifiers are now being widely used in church activities. There are two main reasons for the usefulness of amplifiers. One is that many churches are acoustically poor, with the result that the preacher's voice may not carry throughout the auditorium with satisfactory volume to be easily understood. Someone has suggested that this forms one of the basic causes for the legendary tendency to sleep through the sermon; be that as it may, it is a fact that in certain locations of some churches it is a strain to try to catch the words of the speaker.

Sound Amplifier System in Fashionable Park Avenue Church Carries Services to All Parts of the Auditorium and to an Overflow Audience in the Chapel As Well

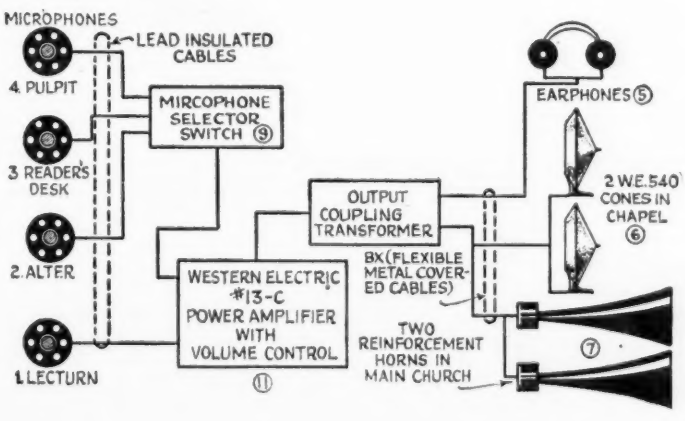


(Above) One corner of St. Bartholomew's Church, showing microphones on the pulpit and prayer-desk. One of the reproducers may be seen high up near the archway. This, with a corresponding reproducer on the other side of the church, reinforces the speaker's voice

Another opportunity for amplifiers is found in some city churches which do not have the seating capacity to accomodate the large congregations that turn out. There are churches in New York City, for instance, which are forced to turn people away from service after service. Such a condition is unfortunate, both for the church and for the worshippers. By means of amplifiers it has been possible to accommodate the overflow in adjoining rooms, the speaker's voice being brought into these rooms through suitable loud speakers.

Typical of this condition is St. Bartholomew's Church at Park Avenue and 51st Street, New York City. This church is of tremendous size with high vaulted ceilings, and in spite of acoustical precautions taken in its design does not permit a speaker's voice to carry comfortably from the pulpit to the rear of the auditorium.

Doctor Robert Norwood, Rector of St. Bartholomew's Church, is a man of such striking thought and eloquence that many of his weekly services fill the church to overflowing. Portable seats are provided



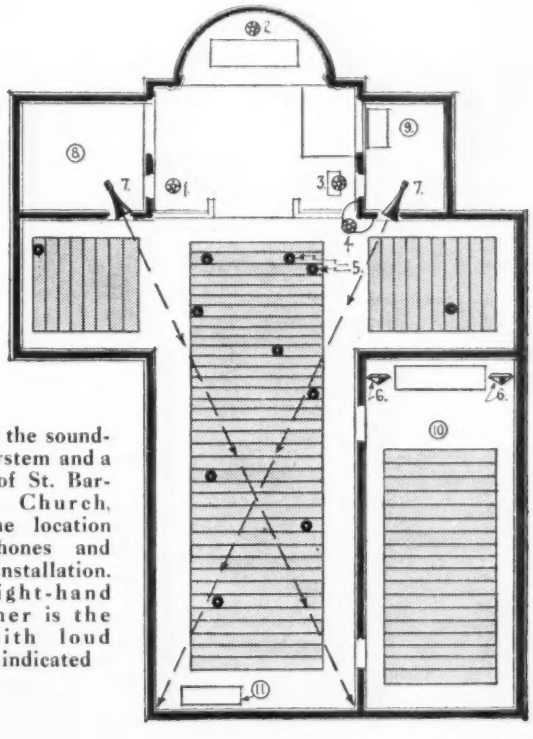


Diagram of the sound-amplifier system and a floor plan of St. Bartholomew's Church, showing the location of microphones and headphone installation. In the right-hand lower corner is the chapel with loud speakers indicated

in every available nook and corner, but in spite of this it was formerly necessary to turn away the overflow.

Faced with the problem of not only improving the coverage of the speaking voice in the auditorium itself, but also taking care of the portion of the audience that would normally be turned away, consideration was given to the installation of an amplifier system as a means of overcoming these difficulties. Mr. George D. Spear, President of the Amplifier Service Company of New York, was called into consultation to work out the details of an amplifier system to meet these requirements.

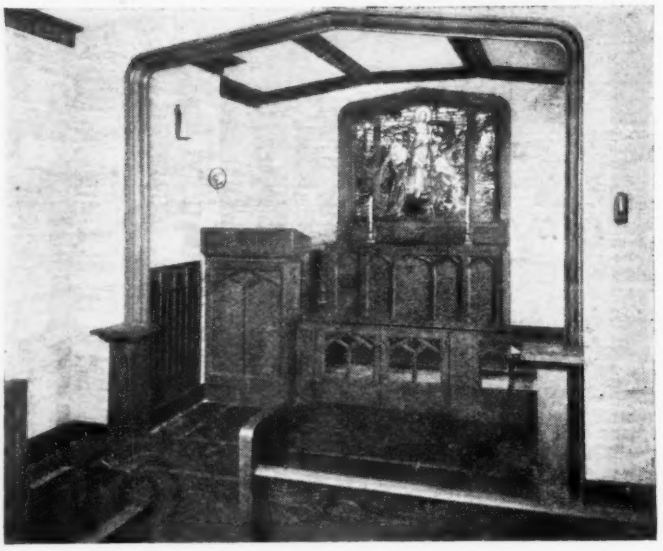
After a study of the situation, Mr. Spear made a preliminary recommendation for the installation of an amplifier and loud speakers which would eliminate the difficulty of hearing from the rear of the auditorium. A temporary test installation was made and demonstrated at a Sunday service. This setup worked out so satisfactorily that the results more than justified the cost of a permanent amplifier installation. The permanent installation was then made, and consisted of a Western Electric No. 13-C amplifier obtaining its input from four microphones located at different points on the rostrum. The amplifier fed into two horn type loud speakers mounted high up at the front of the church and directed toward the rear of the auditorium.

Thus the problem of insufficient carriage of voice from the rostrum was taken care of as far as the main body of the church was concerned. But there was still the problem of taking care of the overflowing congregation, the overflow being larger than ever, due to the improved audibility of the services. Adjoining the main church was a chapel which provided seating accommodations for several hundred persons. The next move in the development of the amplifier system was to extend the loud speaker lines into this chapel. The experiment worked out very satisfactorily. Although it is only natural that an audience should prefer to see as well as hear the speaker, yet it was found that practically all of the congregation that could not find accommodations in the main body of the church were satisfied to sit in the chapel and thus take part in worship.

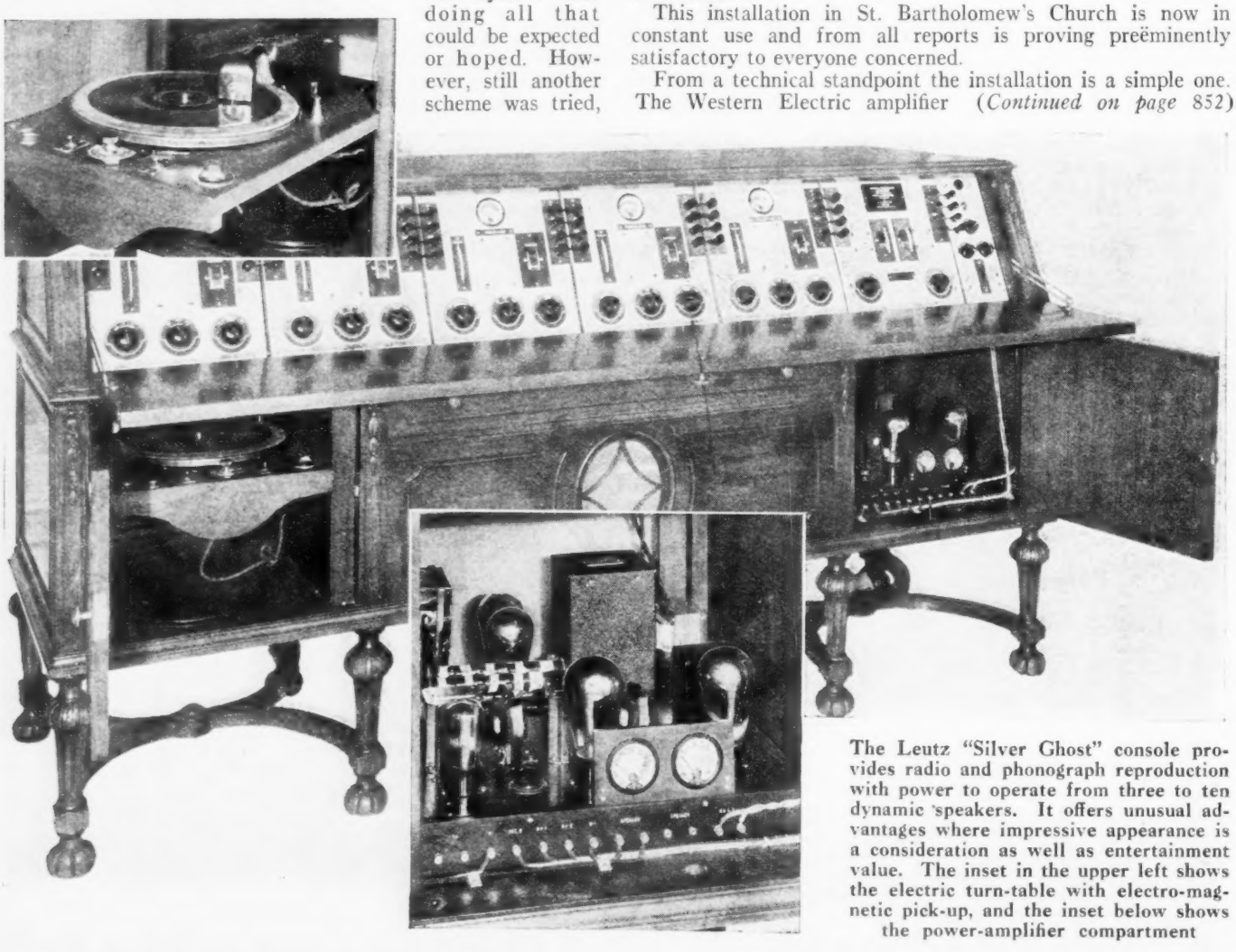
It would appear that in accomplishing these ends the amplifier system was doing all that could be expected or hoped. However, still another scheme was tried, and this too worked out satisfactorily. There was one prominent member of the congregation who was hard of hearing and who had difficulty in following the sermon. As an experiment a special lead was taken off the output transformer of the Western Electric amplifier and an extension was run to this member's pew. A single headphone was then connected to this extension, together with a volume control mounted under the edge of the seat. The success of the experiment was marked and immediate, with the result that ten other members of the congregation who were hard of hearing made application for similar extensions to be run to their pews in various parts of the church.

This installation in St. Bartholomew's Church is now in constant use and from all reports is proving preëminently satisfactory to everyone concerned.

From a technical standpoint the installation is a simple one. The Western Electric amplifier (*Continued on page* 852)



Organ music from phonograph records is provided in this chapel by means of an electrical pick-up and amplifier. The reproducer is mounted behind the grille at the left



The Leutz "Silver Ghost" console provides radio and phonograph reproduction with power to operate from three to ten dynamic speakers. It offers unusual advantages where impressive appearance is a consideration as well as entertainment value. The inset in the upper left shows the electric turn-table with electro-magnetic pick-up, and the inset below shows the power-amplifier compartment

How to Build a Beat-Frequency Oscillator

This Instrument, Having a Range of 20 to 8,000 Cycles, Will Prove of Inestimable Value to Serious-minded Experimenters

By John E. Fetzer*

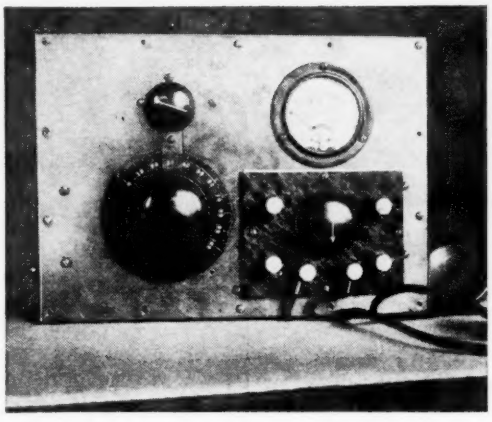
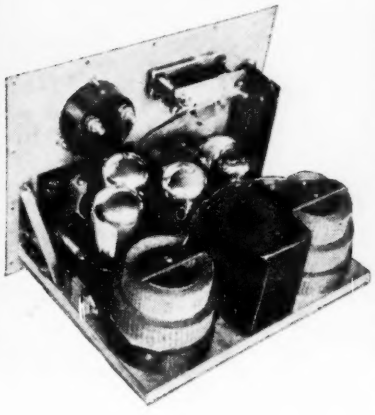


Fig. 1—A view of the front-panel layout of the beat-frequency oscillator



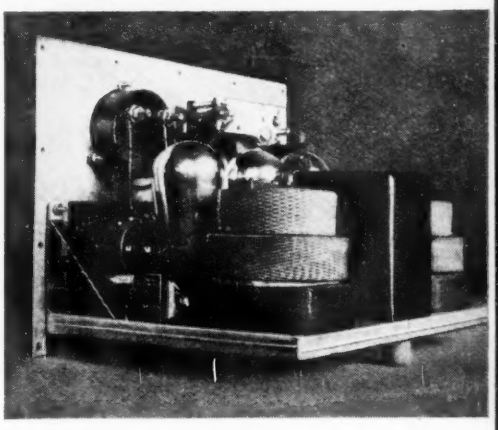


Fig. 2—Above, and to the left are shown the general assembly details of the parts behind the panel

THE audio oscillator plays an indispensable rôle in the activities of experimental and measuremental radio. The many uses to which a device of this kind may be put seem to grow daily. In measuring frequency characteristics of the audio transformers, filter coils, etc., of audio amplifiers, as well as loud speakers, a good audio oscillator is absolutely necessary to the experimenter and radio serviceman. An audio oscillator may well be used in a practical way by the radio dealer to demonstrate to customers the superiority of the frequency response of the newer type of reproducers over those used in older equipment. The broadcast engineer employs a device of this sort almost daily, in lining up remote control lines from the point of microphone pick-up to the radio transmitter. Radio amateurs could well afford to use a tube oscillator of some type to modulate the carrier, instead of the more or less unreliable buzzer.

The many demands for a reliable audio oscillator led the writer into considerable experimental work in collaboration with Dr. G. W. Fox of the University of Michigan, in an effort to produce a device which would reasonably satisfy rigid requirements, and at the same time could be produced with the lowest possible financial expenditure.

**Engineering Director, Station WEMC*

Preliminary Considerations

At first it was attempted to design an oscillator of the more or less familiar type, in which regeneration is produced by coupling the plate circuit with the grid circuit of a vacuum tube through an audio-frequency transformer. Variation in frequency was obtained by means of a multiple contact switch which was connected to a number of fixed condensers. In order to cover the complete audio range it was necessary to use at least two fixed capacities in the grid circuit. Furthermore, a bridged variable condenser across the various fixed capacities, in order to secure the intermediate frequencies between contacts, became indispensable. It is quite obvious that such an arrangement with fixed and variable condensers on contact switches is not ideal from the standpoint of operation, notwithstanding the fact that such contortions seem to find their place in general practice.

It would seem, therefore, from the operational viewpoint, that an ideal arrangement would be an oscillator which would have just one control, for the purpose of securing quickly any desired frequency of from 20 cycles up to 8,000 or more. This relatively high range of frequencies cannot be obtained with a single rotating control with apparatus such as mentioned in the foregoing, but can be easily produced with the so-called beat-frequency audio oscillator by the simple twist of a dial.

A beat-frequency oscillator is nothing more than two radio-frequency oscillators, oscillating at slightly different frequencies, and producing a resultant beat-frequency, which, in our case, must fall within the audio-frequency band. It is obvious that a small change in (*Continued on page* 865)

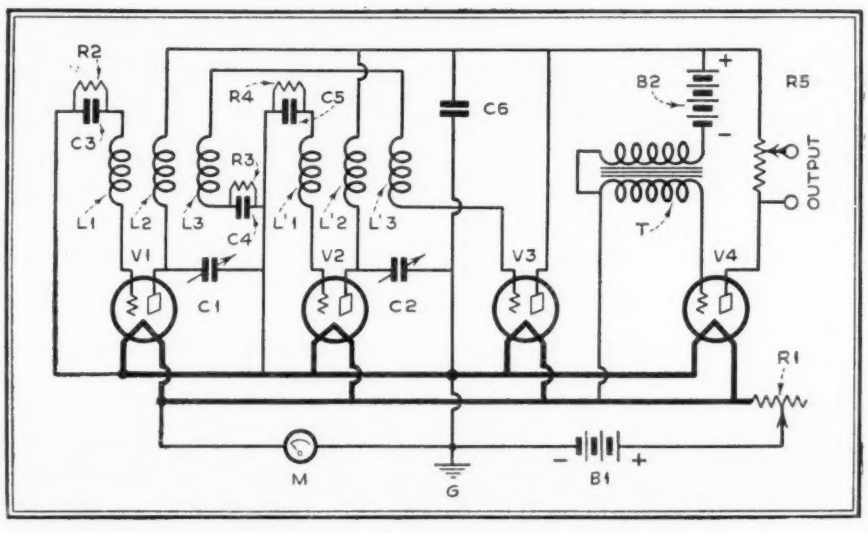


Fig. 3—John E. Fetzer's oscillator circuit employs four tubes, complete details of which are given here. The lettered parts may be identified from the accompanying Parts List

Left—Chief John B. MacDonald of the Tulare, California Police Department, enthusiastically endorses police use of radio

Right—Chief Charles H. Kelley, who directs the activities of his Pasadena, California, policemen in their radio-equipped cars

A New Arm of the Law

More Cities Track Criminals With Radio-Equipped Cars Receiving Their Orders From Police Headquaters

By Ralph L. Peters

EDITOR'S NOTE—*Arrangements had been made for a technical article in this issue of* RADIO NEWS, *taking up the various types of transmitting equipment employed by the police in different cities, including some data on the receivers used in prowling cars. However, such wide-spread interest has been created by Mr. Peters' first article, in the February number, that it seemed advisable to print first a general summary of police radio activities in different parts of the country.*

COMMISSIONER WILLIAM P. RUTLEDGE, of the Detroit police, during 1929 visioned inter-city communication as one of the developments of the next few years. To him goes much of the credit for the speed of radio's use by the police. He was one of the first police officials in the country to become interested in the possibilities of radio, and Detroit was one of the first points to experiment with the new weapon. Through years of poor results, he persisted in his faith in radio and was rewarded during 1928 and 1929 with the remarkable success of the Detroit system.

He then turned his attention to assisting other police departments in the use of radio, ever visioning the time when the police departments of the country would be linked together in one big network.

He expected to resign January 1st, after thirty-five years in police work. His successful application of radio to this work was undoubtedly the high point of his career.

Just as his earlier predictions concerning radio's uses by individual departments came true, so his predictions of the nation-wide network to combat the crook on all sides are coming nearer realization every day.

How a radio system came to be established in Indianapolis is a story in itself—a story of civic cooperation that would be difficult to surpass.

Police Chief Claude W. Morley, of Indianapolis, fellow police officers, members of the Board of Public Safety and of the Council had been advocating the use of radio by the police for some time. Nothing definite had been accomplished. Funds were not forthcoming.

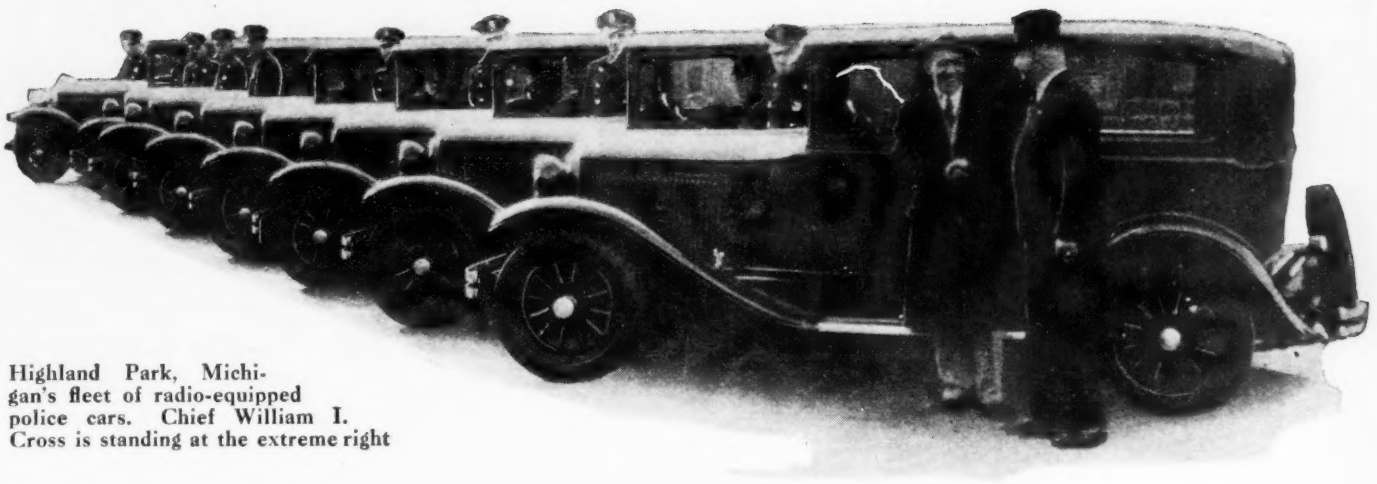
Then the Associated Employers of Indianapolis, Inc., through its secretary, Andrew J. Allen, stepped into the picture. Mr. Allen called together representatives of thirty-three civic, business and trade associations and luncheon clubs, the radio editors of the Indianapolis *News*, *Star* and *Times*, the two local radio stations, WFBM and WKBF; representatives of the Indianapolis Power & Light Co. and the Indiana Bell Telephone Co., together with one company representative each from the radio wholesale trade and the radio retail merchandisers.

The group met at a complimentary dinner. The result of the meeting was the formation of the Citizens' Police Radio Commission, officially appointed by Mayor L. Ert Slack as a public enterprise empowered to raise police radio funds through public subscription.

This was early in the summer. On October 21st, the City Council passed an ordinance accepting the fund of approximately $12,000 which the Citizens' Police Radio Commission had raised as the result of its campaign. This amount was enough to establish the station and equip ten police cars with receiving sets. In addition to the actual money raised by public subscription, much equipment in the way of loud speaker arms, batteries, etc., was donated by various firms and individuals.

The entire cost of the campaign was borne by the Associated Employers as a contribution toward the establishment of the system. In addition the organization's secretary, Mr. Allen, acted as general chairman of the Citizens' Police Radio Commission.

There were two hundred and seventeen contributors to the fund at the time when it was turned over to the City. Of the



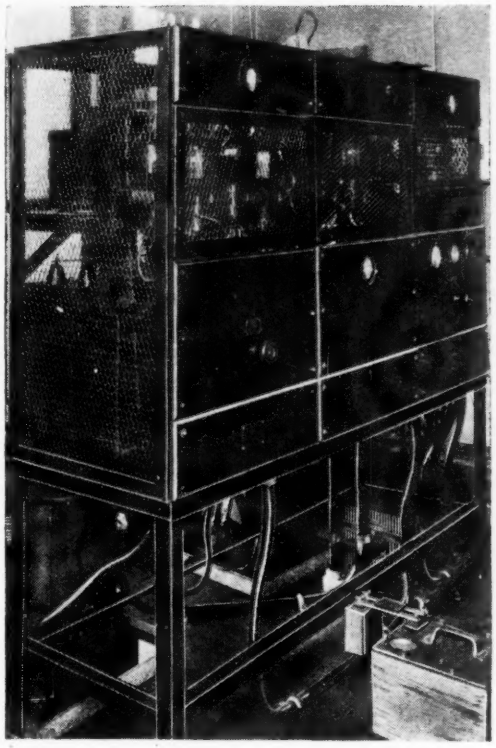
Highland Park, Michigan's fleet of radio-equipped police cars. Chief William I. Cross is standing at the extreme right

total amount raised, $1,000 had been given from the Police and Firemen's Benefit Fund.

That, briefly told, is the way in which the business and professional men of Indianapolis, following the lead set by the Associated Employers, accomplished the task of arming the Indianapolis police with radio.

In Berkeley, Cal., Chief August Vollmer has found it possible and advisable to completely motorize the police department. Consequently, when the department's radio station and radio receivers for the cars were complete and installed, it would mean every police officer in the city would be subject to orders from headquarters by means of radio. The system had not been placed in operation at the time this article was written, but Officer V. A. Leonard, who is in charge of the radio work of the department, said it would be a matter of only a short time before it would be.

When Cincinnati became interested in the use of radio ambitious plans were made. Application was made for a license, and construction of the station was begun as soon as authority was granted. G. C. Smith, executive assistant to City Manager C. O. Sherrill, in outlining the plans, said it was the intention of the city to have about 150 police cars equipped with receiving sets, approximately 75 vehicles of the fire department, 34 fire houses and 12 police stations. The radio station and the police cars were expected to be in operation the first of the year.



Part of the transmitting equipment in the broadcasting room of the Indianapolis police staton

Chief Charles H. Kelley expected to have the Pasadena Police Department's radio station and nine radio-equipped cars in service by the first of the year or shortly afterward. The application for the station has been approved.

L. J. Forbes, chief of the Seattle, Washington, police, had the department's radio station and ten cars equipped with receiving sets in readiness to begin operation December 1st, and was awaiting the granting of a station license. Their plans call for the equipping of all of the department's twenty-five "prowler" cars.

Plans of Chief John R. MacDonald, of the Tulare Police Department, called for the department's station and six radio-equipped cars to be in operation by the first of January. Instead of using loud speakers as is the practice elsewhere, he plans to use headphones. A neon light on the dash of the cars will inform the crew when the radio station is on the air. A member of the crew will then plug into the receiver with his headphone and receive the order.

Chief MacDonald also plans to equip the California Highway Patrol cars operating north and south of Tulare on the main state highway with receiving sets. Then, if criminals escape from the city, the patrol cars will be flashed the warning and be on the alert for the escaping car.

Construction work on the Beaumont, Texas, radio station and receiving sets for eight police automobiles, the fire boat, six trucks and cars of the fire department and three receiving sets for remote points of the city's water works system, was undertaken during the latter part of October.

Chief Carl E. Kennedy, of the Police Department, and his signal superintendent, J. D. Southwell, planned to put the system into operation as soon as construction, testing and administrative details had been worked out.

Atlanta's (Georgia) police chief, James L. Beavers, is hoping the Council will set aside funds early in 1930 for the erection of a radio station and the equipping of twenty cars with receiving sets.

Supt. A. A. Carroll, of the Grand Rapids (Michigan) police, plans at the outset to equip at least four cars with receiving sets and broadcast orders to them from a local broadcasting station that has offered to cooperate. In commenting on the use of radio, he says:

"In my judgment, it will be only a few years before all police departments will be equipped with radio."

It is certain that within the next few months even more names will be ready to add to the list of those who are awakening to the value of police-radio.

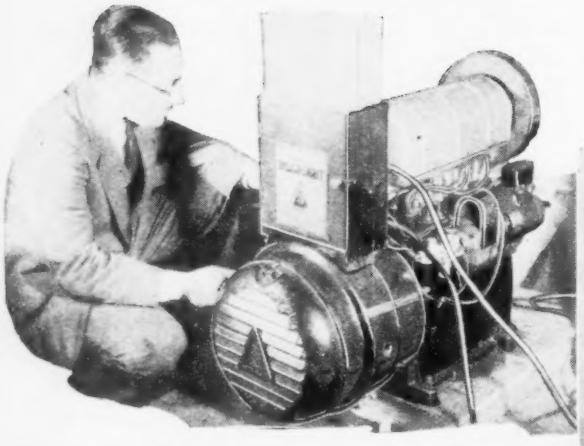
THE success of radio as an aid to the police in apprehending criminals has been proved. So much so, in fact, that its adoption is spreading like wildfire; and cities in all parts of the country, that have not already applied for broadcasting licenses, are making preliminary arrangements with a view to having stations of their own.

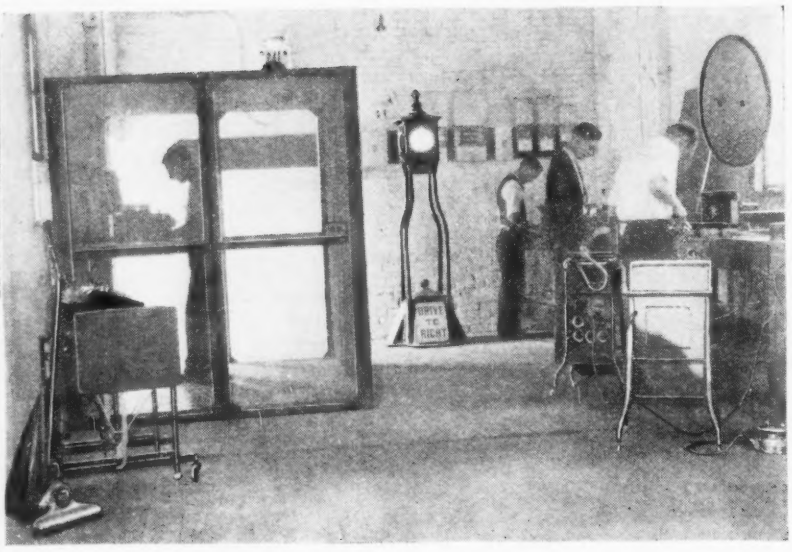
Ralph Peters has made a close study of this growing activity, and is probably better qualified than anyone else to write for RADIO NEWS readers the details of this new use for radio.

Racket

A field-engineer's report on which he took

By Wilbert





(Above) Attaching a condenser and filter to a noisy farm-lighting plant. (Center) A laboratory in which noise-suppressing condensers and filters are designed to muffle interference from household and office appliances and traffic signals. At the right is shown a screened testing room from which electrical interference cannot escape

THE first few days of work here were spent going through the factories in Springfield and making preliminary tests near the lines of the Vermont Hydro Electric Co. and at the generating station of the street railway system.

After going through the factories more time was spent checking the generating station and the Vermont Hydro lines. A number of individual cases were investigated and are reported separately.

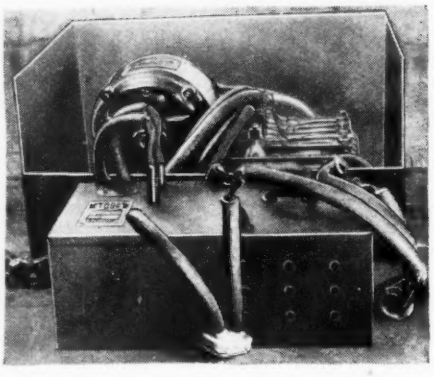
The first factory visited was that of the Fellows Gear Shaper Co. This company takes power from the Vermont Hydro and also generates some for itself, using two machines of about 100 kw. capacity with associated exciters, etc. Most of the factory equipment is powered by three phase induction motors. All such motors are quiet. For purposes of changing speed on certain machines two frequency changers are used. One of these machines was making a slight clicking noise when first tested. A re-check on this machine revealed that the clicking was caused by rough spots on the slip rings which the electrician had fixed in the meantime, and the machine was quiet. Similar troubles with the magnetic chucks were due to the same cause. In the office were a number of Monroe electric adding machines and one No. 2 Burroughs adding machine. These machines were noisy and four Filterette Juniors were used. The Burroughs machine requires a special Filterette to quiet it.

Lovejoy Tool Co. was next tested. All machinery and feeder lines were found to be quiet. No electrically operated office equipment is used here.

The Bryant Chucking Grinder Co. was checked and all machinery found to be quiet.

The Jones and Lamson Co. was next checked. Some of its machinery is driven by d.c. motors. Whenever the frame of the driving motor was not connected to the machine or in some other manner grounded, some noise was heard. Upon grounding, this noise ceased. Five Leeds & Northrup recorders were found to be noisy, as was also some of the office equipment. The filters for this machinery were ordered at the time of the visit. The d.c. generators were quiet.

Parks & Woolson, makers of textile machinery, were checked,



(Right) An interference suppresser attached to a sign flasher. At the right of the motor may be seen the make-and-break contacts, which are miniature "static" broadcasters

and as they use three-phase a.c. motors throughout the plant, no noise was heard. In the office they have five Dictaphones and one Dictaphone shaver. These are all noisy. At the time they refused to put Filterettes on these. One of these machines is used considerably at night.

The J. L. Slack Co. was checked and the machinery in the factory found to be quiet. In the generator rooms the exciters which were ungrounded were found to be very noisy. These exciters, four in all, were grounded and when re-checked were found to be quiet.

The generating plant for the street railway system was found to be very noisy. This plant consists of one a.c. driven d.c. generator and two water-driven machines. Each generator delivers 500 amps. at 550 volts. There is a 5 k.w. 110 v.d.c. machine used as exciter to the a.c. motor. None of this equipment except the a.c. driven machine was grounded. These machines were then grounded and re-checked. The noise was nearly as loud as ever at the machines, but was considerably reduced at certain points outside the building. The method of grounding these machines was to connect the frames to the nearest piping running under the floor. This piping is all tied together by jumpers. How effective this ground may be is not known.

To still further reduce the noise, the No. 55 Filterettes were tried on all but the a.c. driven machine, which was fairly quiet

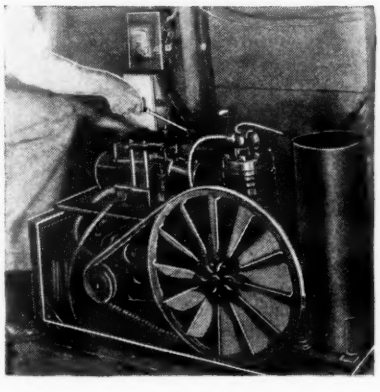
* Tobe Deutschmann Corporation

Suppression

sources of radio interference, and steps to eliminate them.

H. Cook*

Two views of a midget radio receiver and its sensitive antenna used in running down disturbances



(Above) The motors in soda fountain drink mixers are sources of radio interference. (Left) The engineer is pointing to a spark plug, which, along with the other ignition equipment of a gasoline engine, is a generator of crackling noises

anyway. No results at all were obtained with this Filterette which could be noted on the trouble set.

Further suggestions are to improve the ground if possible, and to place chokes in the leads from the generators. These chokes due to the current would be limited to a few turns of the lead wire which they have. These, in connection with a No. 55 Filterette placed closed to the commutator, might be effective.

The lines of the Vermont Hydro Electric Co. were tested at several points as shown on the attached map with the results noted thereon. Naturally there would be considerable difference between noise of poles having grounded guards and those having grounded crossarm braces and those having no ground wires at all. All comparisons between poles adjacent or nearly so were made on poles with similar grounding equipment. One line tested noisier than the other on similar poles and at distances apart of only about 12 feet so that checking was easy. At other points the lines tested quiet and sometimes reversed with respect to noise intensities. More data on this is shown on the drawing. No conclusion could be drawn as all insulators seemed to be in good condition, and on one pole which had been a consistent and previous offender the insulators had been only recently changed, and the old ones when sent in for test were O. K. All the above refers to the 44,000 volt secondaries. The noise was not found in the primary circuits or generating apparatus, although in two stations exciters were not grounded and were noisy, though probably only locally. The noise sounded like corona, only there are times when it is absolutely quiet. It is usually quiet in damp weather. The Vermont Hydro are willing to patrol and note any troubles they can find, and repair them as soon as possible. Their patrolman is not at present equipped with a radio set.

Places visited include the barber shops, banks, beauty parlors, etc., in the business section of Springfield. The noisy ones are listed below with their causes:

The La France Apts. 4 Electrol oil burners, no filter at all.

Ideal Theatre. 2 Electrol oil burners, line filter only; 1 110v. 90A d.c. converter for movie arc.

First National Bank. 1 Burroughs No. 2 machine.

Fitche's Beauty Shop. 1 Hand hair dryer, 1 Floor dryer.

Trayer's Barber Shop. A Motor-driven clippers.

Daschner's Barber Shop. 3 Motor-driven clippers, 1 Hand hair dryer.

Narcissus Beauty Parlor. 1 Hand hair dryer, 1 Floor dryer, 1 Violet Ray.

Adnabrown Garage. 2 Portable drills, 1 Webster oil burner—spark only.

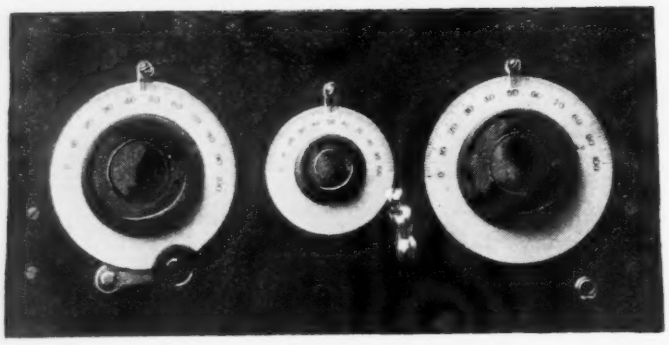
A number of other cases were examined and found to be quiet. In addition to those noted above there is known to be a noisy dental motor and some violet ray equipment which is of course also noisy.

The map herewith shows the general shape of the 44,000 volt lines of the Vermont Hydro. The crosses indicate points checked and are numbered for reference.

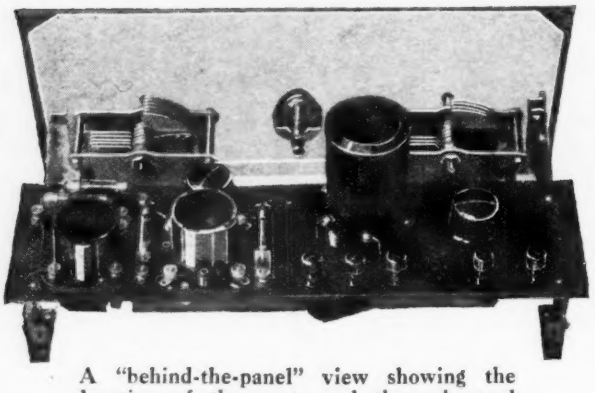
The conditions found at the various checking points are given below:

1. Cavandish Station; exciters only. Wet weather: Check on substation equipment and generators.

2. Pole on Cavandish Claremont (*Continued on page* 870)



Large vernier dials, with husky knobs make for ease of tuning with Wenstrom's "Cornet" short-wave receiver



A "behind-the-panel" view showing the location of the parts and the sub-panel assembly

"The CORNET" Short-Wave RECEIVER

By Lieut. Wm. H. Wenstrom

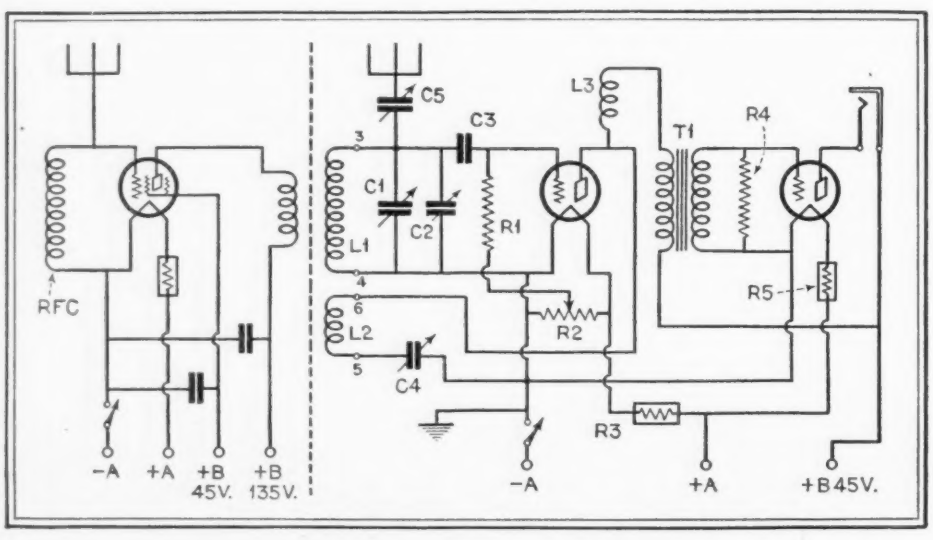
With This Simple Circuit You Can Tune to Any Wavelength Between 10 and 200 Meters

IN the October issue we mentioned our year-old "Cornet" receiver. In response to inquiries we summarize here its salient features. As the name indicates, the receiver is designed primarily for instant wavelength changes, both within a single band and from one band to another.

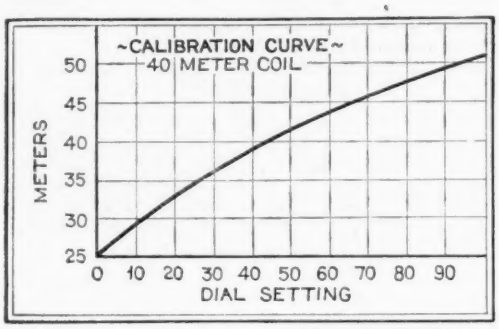
Comparing the receiver with one employing a screen-grid amplifier tube, we find the following disadvantages: less sensitive on a short antenna (though sensitive enough to get phone from Europe and code from Australia); radiates weak oscillations which may cause squeals in other nearby short-wave receivers (though the range is so wide this should occur infrequently). On the other hand, the following advantages appear: more rapid tuning; greater simplicity of construction, maintenance and operation; less cost.

The circuit uses the old amateur standby, capacitatively controlled regeneration, but a few refinements distinguish the set from general practice. First there is the 3 mmfd. vernier condenser, mounted in the center of the panel—a Cardwell midget cut down to one stator and one rotor separated by ¼ inch. This superlatively fine control makes it possible to spread a 40-meter cw whistle over 5 or 10 divisions of the little center dial, and to tune in distant phones with ease and certainty! Then there is the aluminum back panel, to which the Cardwell condensers are grounded, practically eliminating body capacity. Another feature is the detector grid potentiometer, whose knob shows just behind the detector socket in the photograph. This gives positive control of the oscillation characteristics of the detector tube (UX201A, UX200A, or CeCo H), without messing with different grid leak values. The other knob on the subpanel turns the SM 340 midget condenser, chosen for antenna coupling because of its low minimum capacity. None of these features is particularly new, but their combination in one set is the result of several years' operation and a definite search for an ideal amateur receiver.

The coil table and diagram describe coils, wound on SM form 113, suitable for use between 10 and 200 meters with the 165 mmfd. tuning condenser. Other ready-made coils may be used with a suitable condenser, usually 140 mmfd., at some sacrifice of tuning range. The best things about the receiver are its simplicity and its rapid precision in picking out a signal and keeping it tuned in. We have seen more complicated sets which sometimes worked and sometimes did not—which were more sensitive at one part of the band but tuned somewhat

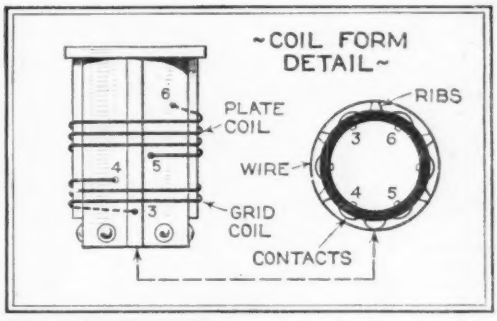


This is the complete circuit of the "Cornet" receiver. That section to the left of the dotted line is shown merely as a suggestion for the addition of a screen-grid r.f. coupling stage. While primarily a short-wave receiver the set will tune to the long waves by substituting long-wave coils at L1 and L2



This curve will help you to locate on the dial any station in the 40-meter band whose wavelength is known

For changing from one waveband to another, it is necessary to use the plug-in type of coil (L1). The Coil Winding Specification Table, below, supplies the data for winding the coils which cover wavelengths from 10 to 2000 meters



A standard S-M No. 113 form is used for the coils. Winding details are shown above

~ COIL WINDING SPECIFICATIONS ~

BAND (METERS)	COIL RANGE (METERS)	GRID TURNS	TICKLER TURNS	REMARKS
—	10 TO 21	2	3	NO. 24 WIRE QUADRUPLE-SPACED
20	14 TO 28	3	3	NO. 24 WIRE TRIPLE-SPACED
40	26 TO 52	6	5	WOUND WITH NO. 26 WIRE ON STANDARD S-M 113 FORM.
80	51 TO 110	15	8	
160	100 TO 200	36	16	
600	550 TO 1100	S-M NO. 111-D		
LONG WAVES	1100 TO 2000	S-M NO. 111-E		

awkwardly at another point. In a year and a half of exacting operation the Cornet (first described in the June, 1928, issue of *Radio Broadcast*) has never failed.

This is the receiver which has been used to obtain the reception data outlined by me in previous articles appearing in RADIO NEWS and it is one that can be highly recommended for satisfactory results.

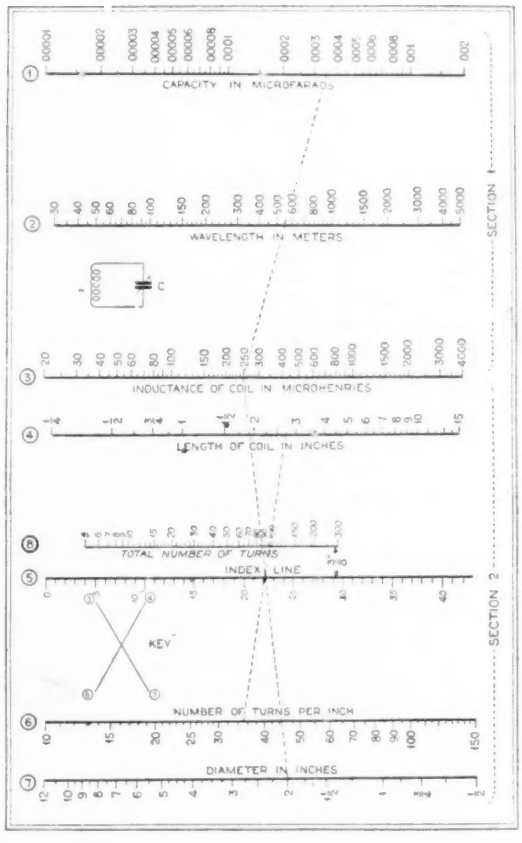
This Chart and a Ruler Will Give You All You Need to Know About Coil Design

By W. Bruce Ross

THE September, 1929, issue of RADIO NEWS contained a calculation chart, showing how a coil of suitable inductance could be wound to cover a definite band of wavelengths when shunted by a variable condenser of known value. Or if the reader has a coil and condenser, it is possible, with this scale, to determine the tuning range of the two, when connected in a tuning circuit.

We have worked out a further application of the above-mentioned chart which makes unnecessary the use of paper and pencil calculations in estimating coil sizes and wavelength ranges. This involves the addition of another line (Number 8), which appears in the accompanying illustration, and which is exactly three-eighths of an inch from the original Index Line, No. 5.

The graduations on this line represent the total number of turns on the coil. We shall call this line No. 8. We already have scales marked "Number of turns per inch" (No. 6), and "Length of coil in inches" (No. 4), so that the new scale must fit in with these. Indeed, it is by means of No. 4 and No. 6 that we graduate No. 8.

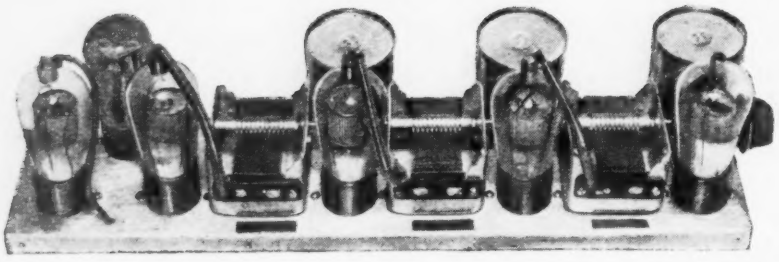


Imagine a coil 1 inch long, wound with wire of such a diameter that there are exactly 10 turns to the inch. There will naturally be 10 turns in the coil. If we lay our straight-edge between 1 on scale No. 4 and 10 on scale No. 6, then the point where we cross the new scale must be the "10" point. Make a short mark on line No. 8, and put 10 beside it lightly. Suppose now that the coil is still 1 inch long but that we wind it with wire having 15 turns to the inch. There will be 15 turns on the coil. Shifting the straight-edge so as to join 15 on No. 6 and 1 on No. 4, we make a mark where it crosses the new line and put a "15" beside it. Similarly an imaginary coil having 20 turns to the inch, and 1 inch long, gives us the 20-turn point on No. 8, and so on up to 50.

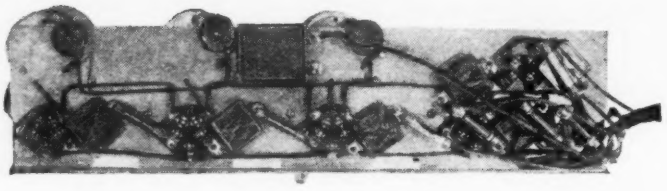
We can go back, and by joining 11, 12, 13, —, 19 on No. 6 with 1 on No. 4, find the points for 11, 12, 13, —, 19 on No. 8; then using points 22, 24, 26, —, 38 on No. 6, find corresponding points on No. 8. (You will easily see that the graduation marks on No. 8 will be closer than those on No. 6, so that, to avoid confusion on the former, we drop the points for 21, 23, —, 39, and all the forties but 45).

We might go on up to 150 on No. 8 by simply joining the points 60, 70, etc. on No. 6 with 1 on No. 4; but it will be found that for these higher numbers the straight-edge makes such an acute angle with the new line that it becomes increasingly difficult to judge precisely where they cross, and errors in graduation are likely to result. Fortunately, there is a simple dodge which will obviate this. Prolong our imaginary coil to 2 inches in length. If we wind it with wire having 30 turns per inch, we will have wound 60 turns in all. Placing the straight-edge so that it joins 30 on No. 6 with 2 on No. 4, we see that it must cross No. 8 at the point "60." We therefore mark it as such. Again, if we wind the 2-inch long coil with 35-turns-per-inch wire, it will have a total of 70 turns. Joining 35 on No. 6 with 2 on No. 4, we locate "70" on No. 8. And similarly, joining points "40," "45," and "50" on No. 6 with "2" on No. 4 gives us points "80," "90," and "100" on No. 8. It will be found advisable to put in more than the 55, 65, 75, etc., points on the new scale, because otherwise the graduations would be too close for easy reading.

As a check, you will notice that the (*Continued on page* 873)



Extremely compact is Mr. Egert's auto-radio receiver, as shown by the two photographs here. To the left—the arrangement of the tubes, condensers and coils on top of the chassis



In this underside view of the chassis (below) is shown the location of the chokes, fixed condensers and, at the right, the complete resistance-coupled audio channel

AUTO-RADIO RECEIVER DESIGN

By Samuel Egert

Compactness, Power Supply, Type of Circuit and Space Limitation Are All Points Which Confront the Designer for Solution

THE reader no doubt has often turned the pages of a magazine such as this and noticed the great similarity among the hook-ups which appear on almost every page. To an unpracticed eye all the circuits look alike, but to the trained builder each circuit has some outstanding advantage and at the same time certain disadvantages which are not present in the others. As a result, when it becomes necessary to design a circuit for a new and novel purpose the engineer is often in a quandary concerning the circuit he should use. Shall we use a tuned antenna stage? Different aerials will affect the tuning. Shall he use an untuned antenna stage? An extra tube is required which will not add much to the over-all gain. Shall he use transformers? The frequency characteristics will not be perfect, and transformers add to the weight. Shall he use resistance coupling? The gain will not be as high per stage. And in this manner practically every part of the proposed circuit lays itself open to the question, are these disadvantages offset by equal advantages? It is the purpose of this article to deal with some of the problems involved in designing a good, reliable and economical set for automobile reception. In order to do so as systematically as possible we shall begin from the input of the receiver and work through to the output.

The first question to arise is, Shall we or shall we not make the input stage a tuned affair with the accompanying necessity of an extra tuned control? It would be advantageous to do this because of the extra gain, but the extra control digs seriously into this advantage. Since space is limited in a car, and since we want our set to be controlled from the steering wheel, the advantages of an untuned input stage make themselves manifest.

Shall we use tuned impedance coupling or shall we use transformers? If it were not for the fact that the screen-grid tube is the most suitable for our purpose, we would use transformers; but since a transformer with an aperiodic primary would not transfer sufficient impedance from the tuned stage to act as a load upon the plate of the preceding tube, and since with the small antenna permissible in a car selectivity is not an important factor, we shall use direct impedance as the means for coupling.

Now we come to the detector. Shall it be condenser and grid leak or power detector? The condenser and grid leak arrangement, although the more sensitive, will not handle as loud a signal without distortion as the bias type of detector. Also, since we are going to use several (*Continued on page* 875)

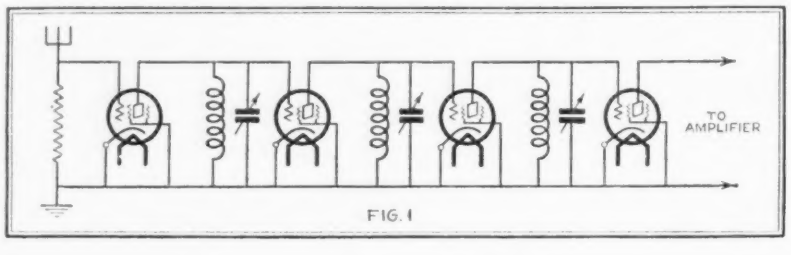


FIG. 1

Fig. 1—The tuner section. The fundamental circuit around which the receiver was designed is shown at the left

Fig. 2—After investigations conducted to determine the ultimate in circuits satisfactory for auto-radio use, the one shown below was finally developed. The first tube, a coupling tube, is followed by two tuned r.f. stages, a tuned detector and two stages of resistance-coupled audio amplification

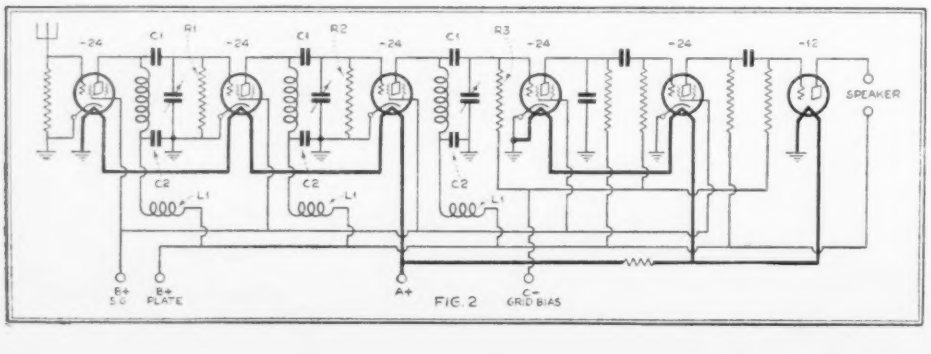


FIG. 2

Fig. 3—A characteristic curve of an r.f. tube, showing the operating point adjusted to zero grid bias

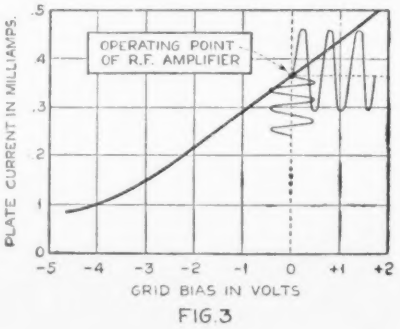


FIG. 3

ELMORE B. LYFORD, B.S.[1]

Mr. Lyford is a graduate of Wesleyan University, where he specialized in mathematics and physics, also devoting a large portion of his time to the study of radio engineering.

He has been associated with the University Radio Manufacturing Corporation, the Electrical Testing Laboratories and RCA Photophone, Incorporated, where he is now in the recording engineering department.

He was the co-designer of the Henry-Lyford receiver, and is an associate member of the Institute of Radio Engineers.

Information Sheets

A New Radio News Feature

WITH this issue RADIO NEWS inaugurates a new department. It will include data which, in many cases, are not readily available to the average experimenter, and there will be charts and other useful information which will prove most helpful even to the trained engineer.

To facilitate filing, each sheet will be given a decimal classification in accordance with the Dewey system extension. The explanation of this system may be obtained from the Government by enclosing ten cents with a request for Bureau of Standards Circular No. 138, addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C.

In each succeeding issue there will be four sheets, two devoted to elementary subjects and the other two intended to be of interest to those of more advanced engineering training.

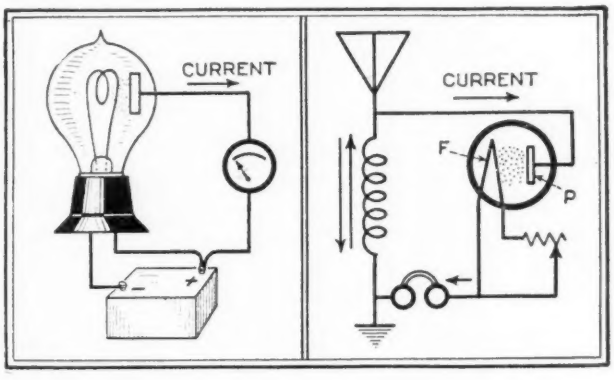
RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

The Two-Element Vacuum Tube

Index No. R-332.1

IT has been known for over a hundred years that when a metal is brought to white heat, the air surrounding it becomes a conductor of electricity. This phenomenon was studied by Elster and Geitel between 1882 and 1889, and they found out also that a conductor brought near an incandescent metal filament acquired a negative charge.



About the same time Edison discovered that if a metal plate were placed around or within his carbon filament lamp, a current flowed when it was connected to the positive end of the filament, but not if it were connected to the negative end. This has since been called the "Edison effect" and is illustrated by the accompanying drawing. Edison did not, however, make any practical use of this phenomenon.

J. J. Thompson, in 1899, showed that this effect was caused by the emission of free negative electrons from the hot filament, which were attracted to the positively charged plate. In 1901, O. W. Richardson gave an explanation of the mechanism of the liberation of electrons from hot bodies, which was hailed as an important contribution to pure scientific theory, even though it did not appear to have any practical value.

It remained for J. A. Fleming to conceive the idea of making use of this effect for rectification, and therefore the detection, of radio-frequency signals. This was in 1905. Such a "Fleming valve" was widely used, instead of a crystal detector, in series with a telephone receiver in a circuit for radio reception. An arrangement of this kind, illustrated, constituted the most sensitive radio receiver it was then possible to make.

This circuit, though now obsolete, illustrates very well the rectifying action of electron emission. The alternating radio-frequency current picked up by the antenna makes the upper end of the coil first positive and then negative with respect to the lower grounded end. This makes the plate correspondingly positive and then negative with respect to the filament. When the plate is positive, it attracts negative electrons from the filament and current flows through the phones, but when the plate is negative no current flows. Thus an alternating current in the antenna is changed to a pulsating direct current in the phones.

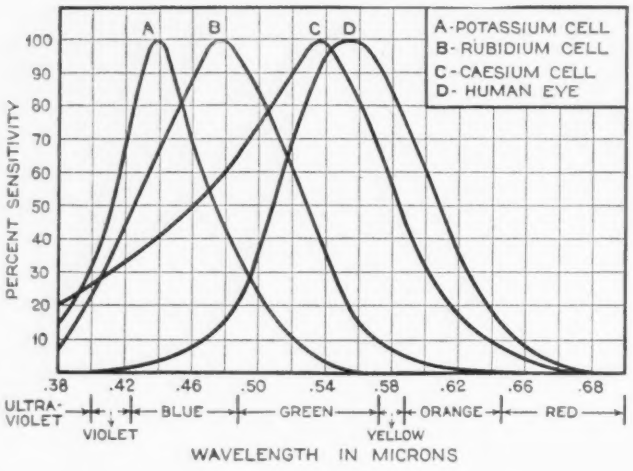
RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

Color-Sensitivity of Photoelectric Cells

Index No. R-535.31

THE activity and sensitivity of a photoelectric cell depends upon the material with which the inner surface of the bulb is coated. All metals are photoelectrically active to a greater or less degree, but the most active ones have been found to be those which chemists call "rare earths," such as caesium, rubidium, uranium, etc.



No known photoelectrically active substances are sensitive indiscriminately to all wavelengths of light—each such substance is affected by a definite band of light waves only, and has its point of maximum sensitivity at some wavelength within the band. In general, the more active substances have their point of maximum sensitivity within the visible portion of the spectrum, while the less active substances respond best to light in the extreme violet or ultra-violet portion of the spectrum.

The curves given in the accompanying chart show the color-sensitivity characteristics of three common types of photoelectric cells. These curves remain practically unchanged regardless of the shape or size of the cell in which the metal may be employed. The shape and size of the cell have much to do with its total output, but the relative sensitivity of the cell to various wavelengths of light is determined almost entirely by the active material employed.

For purposes of comparison, the color-sensitivity curve of the average human eye is also shown, and all the curves have been drawn with the point of maximum response at 100%. This should not be taken to mean that under the same conditions all of these metals are equally active, for such is not the case. These curves simply show where the point of maximum response comes, and how rapidly this response falls off as the wavelength of the incident light is increased or decreased from this point.

RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

Voltage Multipliers for Small Meters

Index No. R-264.1

ANY milliammeter may be used as a voltmeter by using a resistance of the proper size in series with it. It may be made into a multi-range voltmeter by using several resistances, and selecting the appropriate one by the use of a selector switch, as shown in the accompanying diagram.

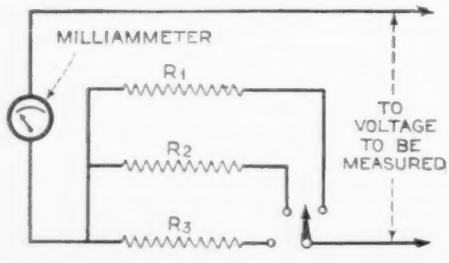
When deciding upon the proper resistance value to employ as a multiplier, Ohm's law must be taken into consideration:

$$R \text{ (ohms)} = \frac{E \text{ (full scale reading desired—volts)}}{I \text{ (full scale deflection of meter—amperes)}}$$

The accompanying table gives the correct resistance values to use, with each of the milliammeters shown across the top, to obtain the voltage range shown in the first column.

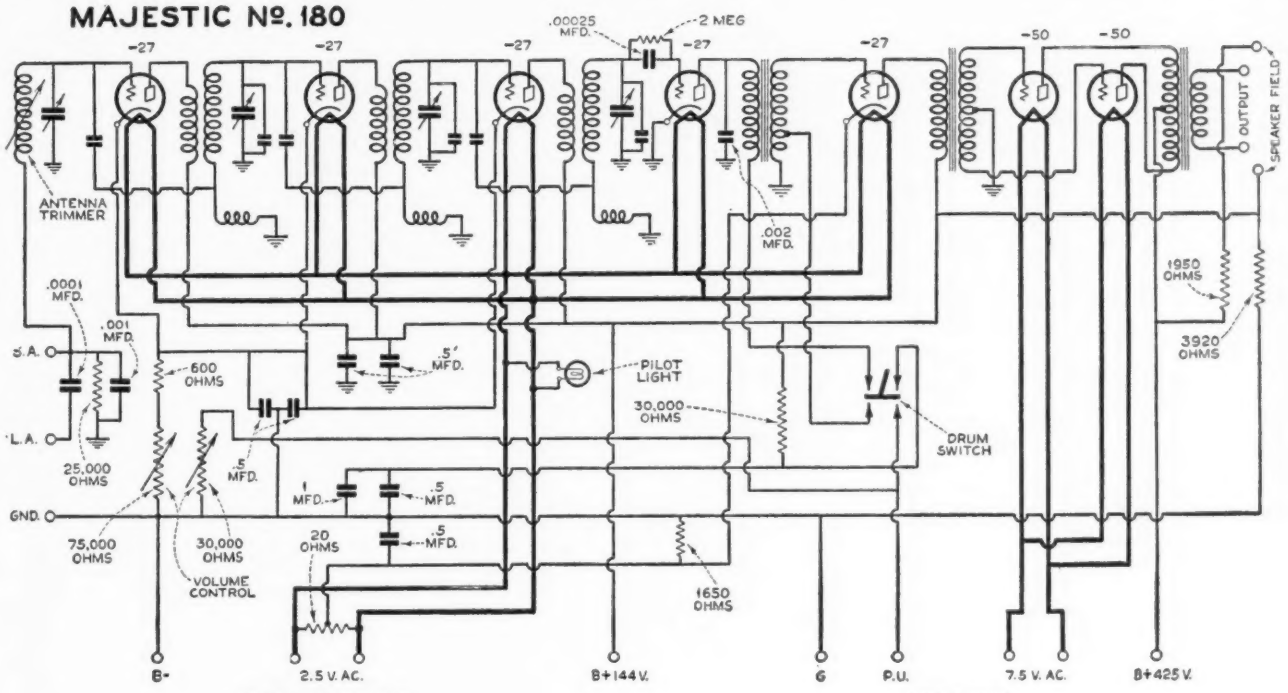
If a multi-range voltmeter is desired, several different resistances may be used in series with the same milliammeter, and the appropriate one for each reading selected by means of a switch, as shown in the accompanying hook-up.

With a good milliammeter, the accuracy of the voltage readings will depend almost entirely upon the accuracy of the resistance used, and these should be the best obtainable. They must also be capable of carrying a current equal to the milliampere range of the meter used.



VOLTAGE RANGE DESIRED	MILLIAMMETER SCALE					
	1.0 MA.	1.5 MA	2.0 MA	5.0 MA	10.0 MA	50.0 MA.
1	1,000	667	500	200	100	20
5	5,000	3,333	2,500	1,000	500	100
10	10,000	6,667	5,000	2,000	1,000	200
15	15,000	10,000	7,500	3,000	1,500	300
50	50,000	33,333	25,000	10,000	5,000	1,000
100	100,000	66,667	50,000	20,000	10,000	2,000
150	150,000	100,000	75,000	30,000	15,000	3,000
500	500,000	333,333	250,000	100,000	50,000	10,000

Radio News Manufactured Receiver Circuits



MAJESTIC

IN the seven-tube Majestic No. 180 receiver two –50 tubes arranged in push-pull provide exceptionally fine tone quality with little or no possibility of distortion due to overloading.

Five –27 tubes make up the remainder of the circuit, three being used as radio-frequency amplifiers, one as a detector and one as a first-stage audio-frequency amplifier.

Provision is made for either a short or a long antenna and peaking of the antenna stage is obtained by the use of an antenna trimmer.

A drum switch allows changeover from a radio program to the playing of phonograph records, by connecting a phonograph pickup in the secondary circuit of the first-stage audio-frequency amplifier.

The drawing above shows only the circuit diagram of the radio-frequency amplifier, detector and audio-frequency amplifier portions of the receiver.

The power pack employs two –81 tubes in a standard circuit for full-wave rectification. The necessary power for the excitation of the field coil of the dynamic speaker is obtained from the same power pack. A voltage regulator, connected in series with the primary of the power transformer provides even volume and distortionless quality.

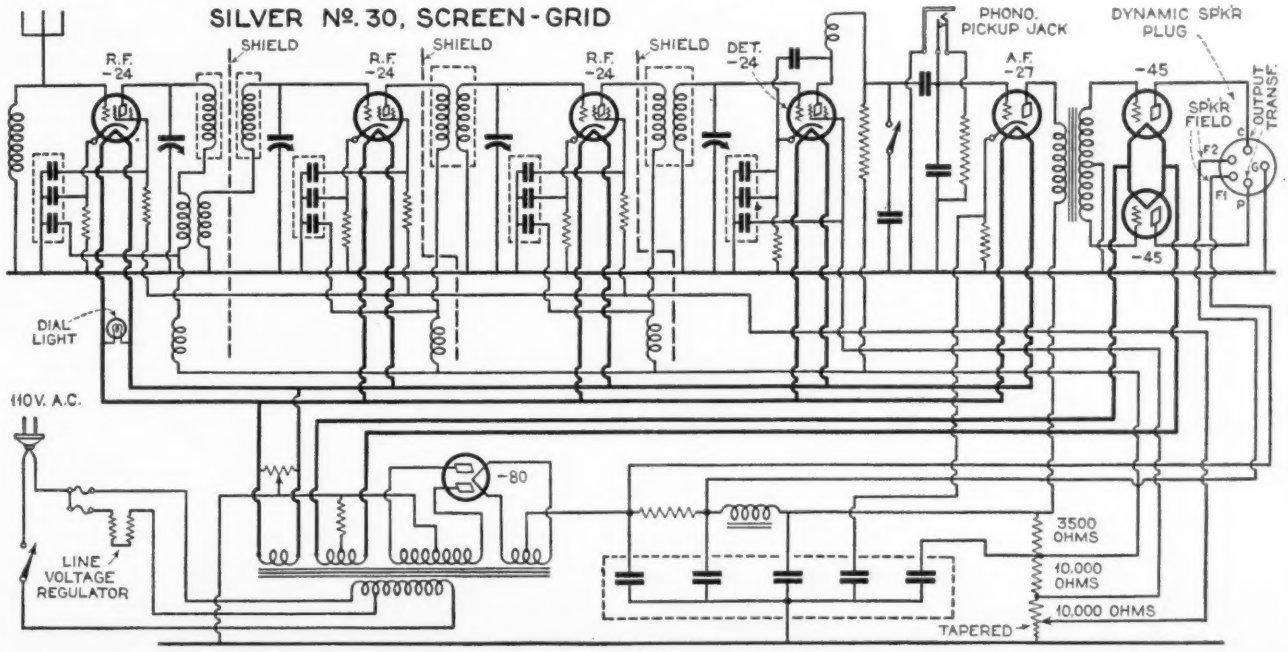
SILVER

IN the Silver Screen-Grid 30 receiver four screen-grid tubes are used, three of them functioning as high gain r.f. amplifiers, the fourth as a screen-grid power detector. The first audio stage, employing a –27 tube, is coupled to the detector output through a resistance-coupling unit, so that the impedance relations between the detector plate and the plate load may be satisfied. Incorporated in this part of the circuit is a switch which throws in or out a shunt condenser across the plate resistor so that regulation of the bass or treble notes may be obtained. In other words, the operation of the switch accentuates one or the other frequency extreme.

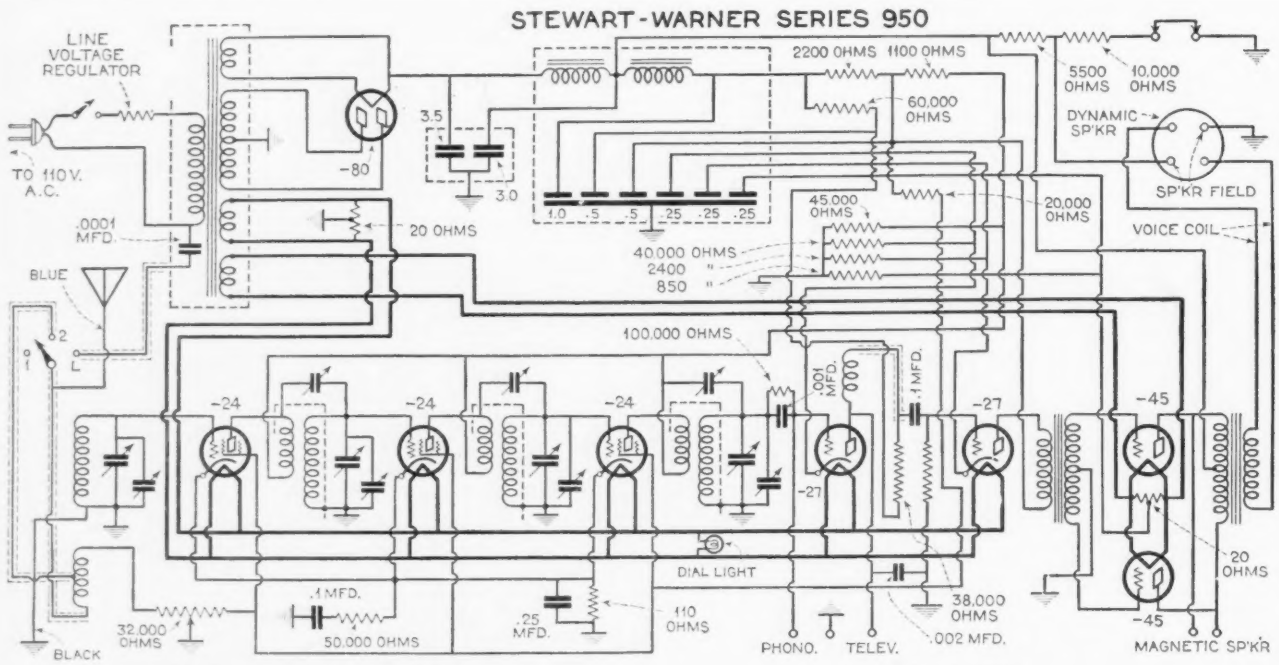
In the grid circuit of the first-stage audio amplifier tube is a closed-circuit jack which is intended to take a phonograph pickup for the electrical reproduction of records through the receiver's audio channel.

A pair of –45's arranged in push-pull fashion complete the audio amplifier.

A standard power-supply unit provides the plate and filament voltages for all of the tubes. One feature of the power unit is the line-voltage regulator which maintains a steady non-fluctuating voltage supply to the line transformer despite line voltage variations.



Radio News Manufactured Receiver Circuits



STEWART-WARNER

THREE –24 or a.c. screen grid tubes, two –27 or a.c. heater type tubes, a pair of –45 output power amplifier tubes and a single –80 or full-wave rectifier are the tubes which are employed in the Stewart-Warner Series 950 a.c. operated receiver.

The three screen-grid tubes are used in the three-stage r.f. amplifier, which is stabilized by the employment of neutralizing or stabilizing condensers. The tuning condensers are shunted with equalizing capacities so that perfect alignment of a resistance-coupling unit.

Coupling between the detector and first audio amplifier tubes, both –27 type tubes, is accomplished through the use of a resistance coupling unit.

Push-pull transformers between the first a.f. stage and the pair of –45 tubes and between the latter and the loud speaker, complete the audio channel.

Full details of the power supply unit, which follows standard lines, are given in the circuit above.

KOLSTER

THE a.c. filament type of tube, otherwise known as the –26, is used in the antenna coupling stage and the three tuned radio-frequency amplifier stages of the Kolster, Series K-21 a.c. operated receiver.

The heater type a.c. tube (–27) is used in the detector stage.

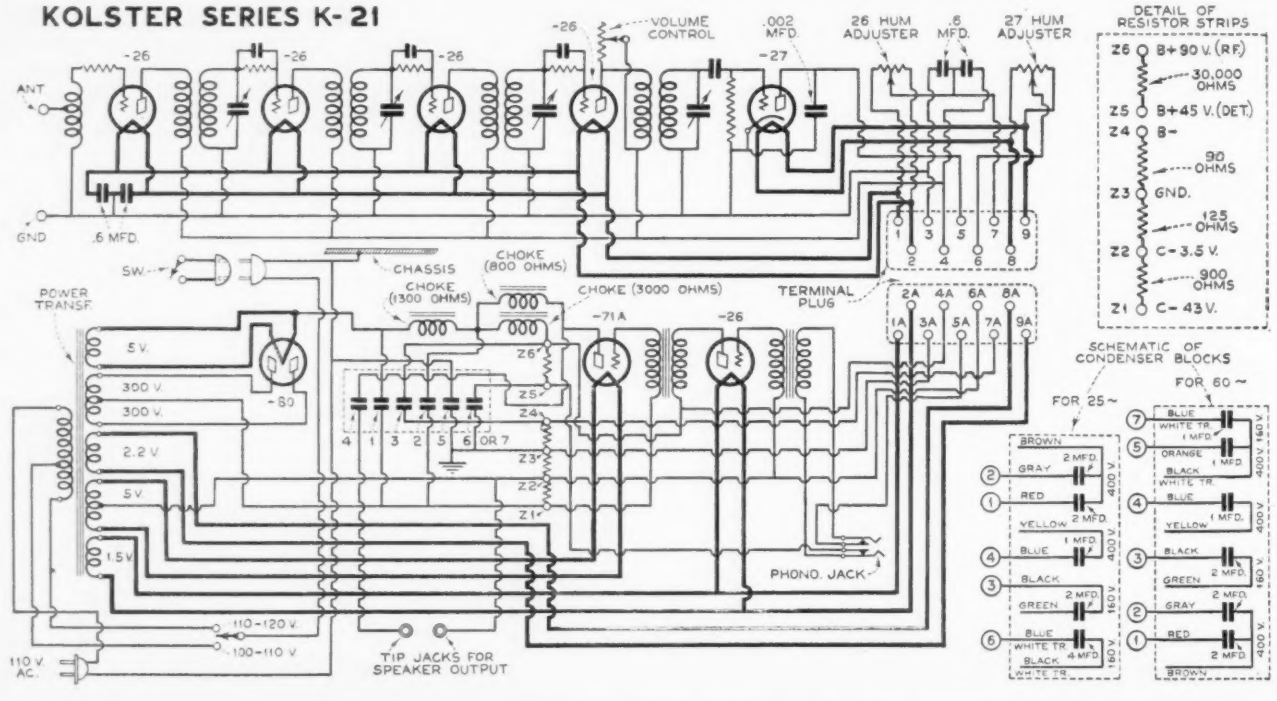
These five tubes complete the tuner section which is constructed as a separate unit, having its own chassis.

The audio amplifier, consisting of two transformer stages, and the power supply unit comprise the second unit of the receiver. Conection between the two units is made through a terminal board or plug arrangement as shown in the circuit below.

The first audio stage employs a –26 tube while the final audio stage employs a single –71A tube in the output.

Provision is made for the plugging in of a phonograph pickup so that the audio channel may be used for the reproduction of phonograph music.

Details of the condenser and resistance bank of the power supply are shown in detail below.

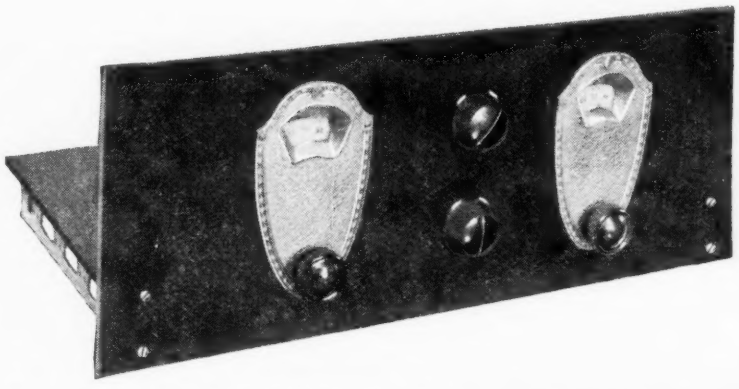


The Junior RADIO Guild

How To Build The "J R G" Six

LESSON NUMBER EIGHT

New Circuit Employs Two Screen-Grid Tubes and Regenerative Detector in Tuner Section



Two tuning controls, a volume control and a regenerator control make the operation of this set easy

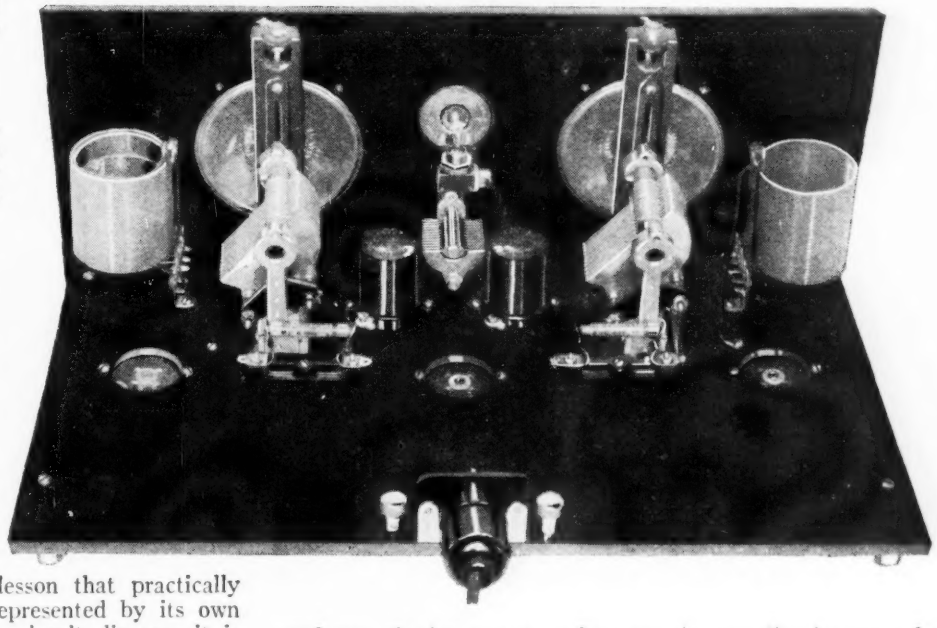
JUNIOR GUILDERS have been taught, in previous lessons, how to build a five-tube broadcast receiver. That receiver is now more than a year old. It employed only one screen-grid tube in the r.f. tuner.

This lesson is the first of the second series, and describes completely the construction of the tuner unit which uses two screen-grid tubes and a power tube in the detector.

From the accompanying illustrations it will be immediately evident that the design of the receiver has been made as simple as possible. At the same time appearance has not been sacrificed.

Designed and built in the laboratory of RADIO NEWS, the receiver is one that has the full unqualified approval of the Technical Staff.

Next month the second unit, the resistance-coupled audio amplifier, of new and startling design, will be fully described.



Note how a symmetrical layout enhances the appearance of the receiver's "innards," at the same time making for shortness of connections between pieces of apparatus

LAST month's Junior Radio Guild lesson took up the question of symbols and circuits. In that lesson we showed how it was possible to represent on paper the details of a circuit in symbolic form instead of other methods producing complications which would necessarily have resulted had we drawn the various parts of the circuit in picture form. It will be recalled from this former lesson that practically every part which is used in radio is represented by its own special symbol and that to construct a circuit diagram it is only necessary to take collection of these symbols which represent the parts that are to be used and connect them one to the other in the correct order in which they will be connected in the actual receiver, or whatever is to be built. In this lesson, also, we showed the circuit diagram of a section of a receiver which would be featured in the future Junior Radio Guild lessons. As was explained, this receiver is to be described in units, that is, a section at a time, so that you may build first one unit and study it as you go along, and then after you are entirely familiar with it, you may construct the next addition to it. In this way you tackle the problem in easy stages, not biting off more than you can chew at one time. Last month we showed the circuit diagram of the detector part of the circuit. In this lesson we show the complete circuit diagram of the entire tuner section which, upon observation of Fig. 1 is seen to consist of one untuned antenna stage and two tuned stages. Briefly described, the tuner section consists of one untuned stage of radio-frequency amplification acting as a coupling stage, a tuned stage of radio-frequency amplification employing the -22 screen-grid tube and a tuned detector stage employing a -12A tube. The detector circuit is of the regenerative kind, capacity feedback being used to obtain regeneration. That is to say, a small variable condenser is connected from the plate of the detector tube to a tickler coil which is fixed in its relation to the secondary coil of that detector. Variation of this small condenser obtains greater or less capacity coupling between the plate and the grid circuits thereby resulting in a feedback which gives us regeneration. By using the screen-grid tube in first and second radio-frequency amplifier stages, we obtain a very high signal amplification—more than would be obtained if the ordinary type -01A tubes were used. While the screen-grid tube has a theoretical amplification factor of about 250, the practical amplification which can be obtained with existing apparatus is roughly about 30 per stage. However, as an indication of the superiority of the -22 over the -01A, this figure can be compared with the amplification factor of about 8 which is obtained with the -01A tube. From practice it has been found advisable in some circuits to use the type -12A tube as the detector tube, especially where regeneration is employed, as the results obtained usually are far better than when the ordinary type of detector tubes are used.

The lessons to follow will take up the construction of a three-stage resistance-coupled audio-frequency amplifier with transformer-coupled output. The novel feature of this part of the circuit, the audio amplifier, is the adaptation of the screen-grid tube to audio-frequency amplification, this tube being used in the first and second stages of the audio-frequency amplifier. A following lesson will take up the construction of a suitable power supply unit which will supply plate voltage to the entire receiver.

From the photographs which accompany this description it will be seen that great care has been exercised in making the

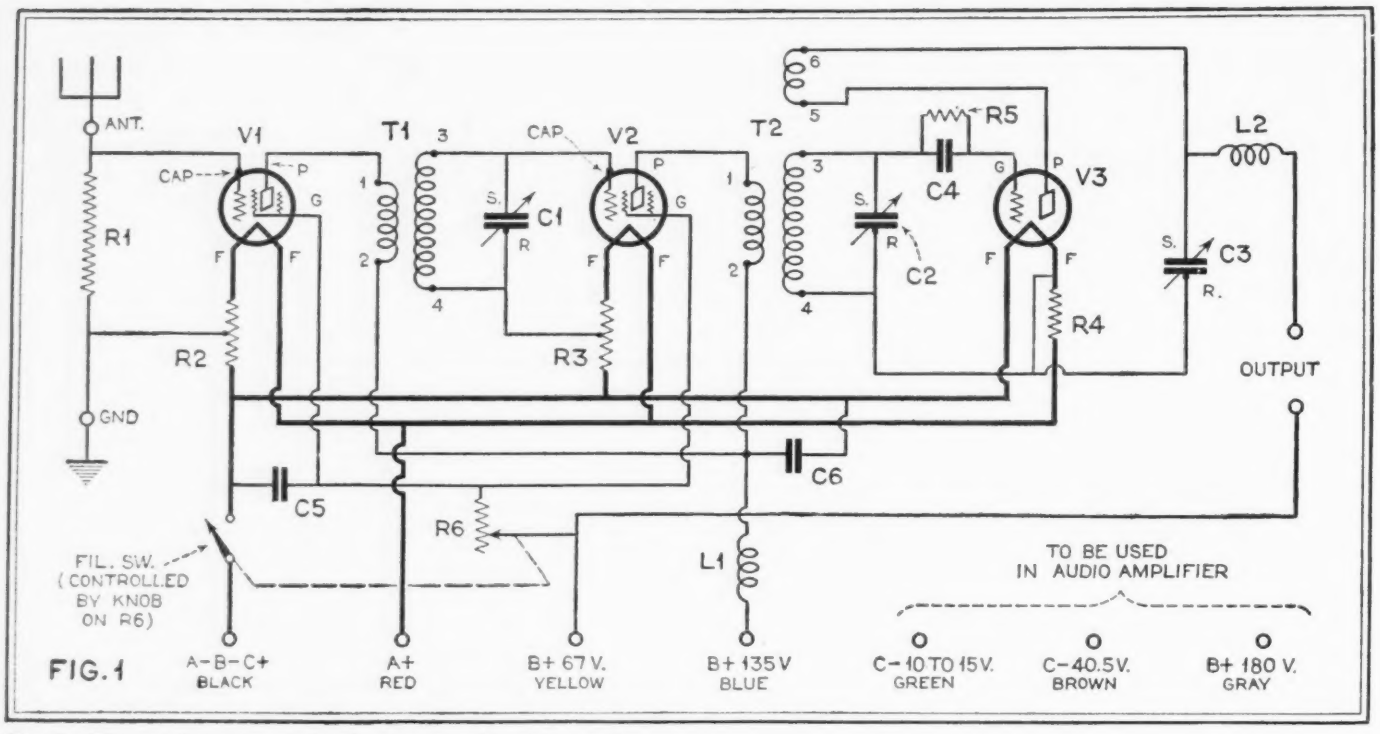


FIG. 1

Fig. 1. Three tubes, two of the d.c. screen-grid variety and one of the power type, are employed in the tuner section of this receiver. The first, a –22, is used as a coupling medium between the antenna and the first tuned r.f. stage. The second, another d.c. screen-grid tube, is used in a high-gain r.f. amplifier circuit. The third, a type –12A tube, is used in the capacitatively coupled regenerative detector circuit

layout of the apparatus on the base and the panel one of symmetrical appearance. That is, the positions of the apparatus have been balanced so that a pleasing appearance results. The receiver is of two-dial control, with one adjustment for volume and another for regeneration. The volume control has connected to it a switch for turning on and off the filament current to the receiver, thus embodying in one control the features of the control of volume and also the control of filament current. Another feature of the construction of this receiver lies in the novel way in which the sub-panel is mounted on brackets so as to allow placement of some of the parts, such as filament resistors, by-pass condensers, etc., underneath, thus making for easy wiring. Such a method of construction allows all of the wiring, with few exceptions, to be placed entirely underneath the sub-panel, the wiring being of the point-to-point type.

In this lesson we take up only the construction of the tuner section of the complete six-tube receiver. That is, only the first three tubes, the coupling tube, the tuned screen-grid r.f. tube and the regenerative detector tube and their associated apparatus. These three tubes are arranged, with the coils, condensers, etc., along the front edge of a bakelite sub-base. A later lesson will describe how the complete audio channel is arranged along the rear edge of this base.

The photographs which accompany this article illustrate the location of each of the parts. The layout, Fig. 3, gives the drilling specifications for the holes which take these pieces of equipment. These illustrations and the drawings should be studied carefully before any attempt is made actually to start the construction.

Construction Details

Assuming that all the parts, as listed in the parts list, have been obtained, the first step to take in the actual construction of the receiver is to prepare the sub-panel to take the parts which are to be mounted on it. To do this, lay out the position of the holes, as shown in Fig. 3. With a hammer and a center punch or a nail sharpened to a fine point, the center marks of all these holes should be made and then the holes drilled with a No. 28 drill. Then, when all the holes have been drilled, those that require it may be enlarged by redrilling with a larger-sized drill to the size specified.

Two slots must be cut in the front edge of the base to make

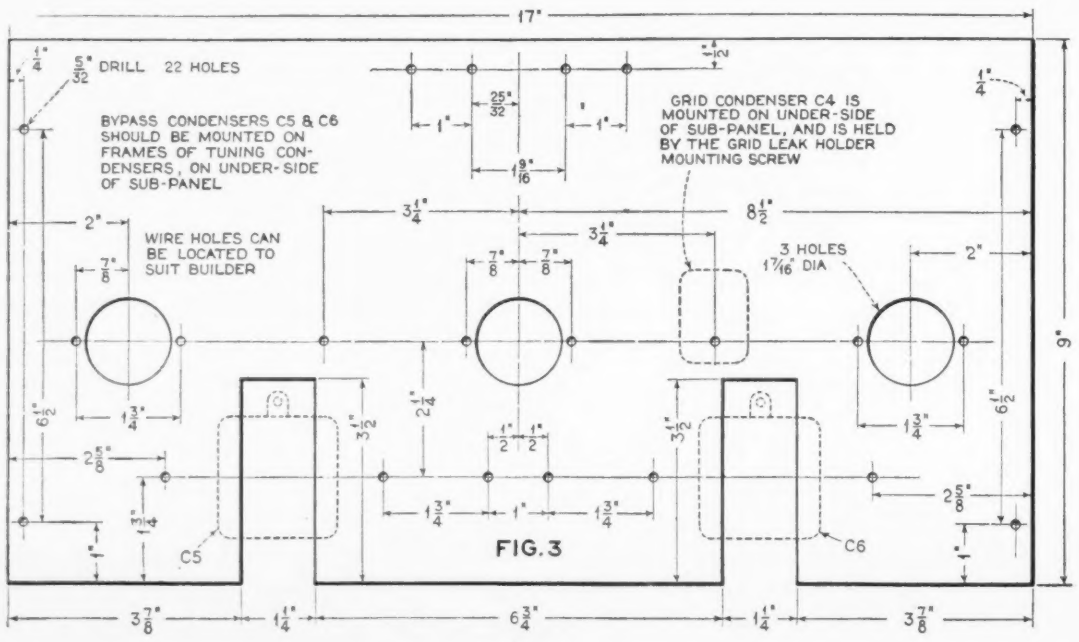


FIG. 3

Fig. 3. In drilling the holes for mounting the parts on the sub-base, the drilling layout as shown here should be carefully followed. The dotted lines indicate those parts which are mounted underneath the sub-base. Filament resistors R2, R3 and R4 are placed underneath, near the socket of the tube to which they connect, being supported by the wiring, or fastened to a convenient bolt

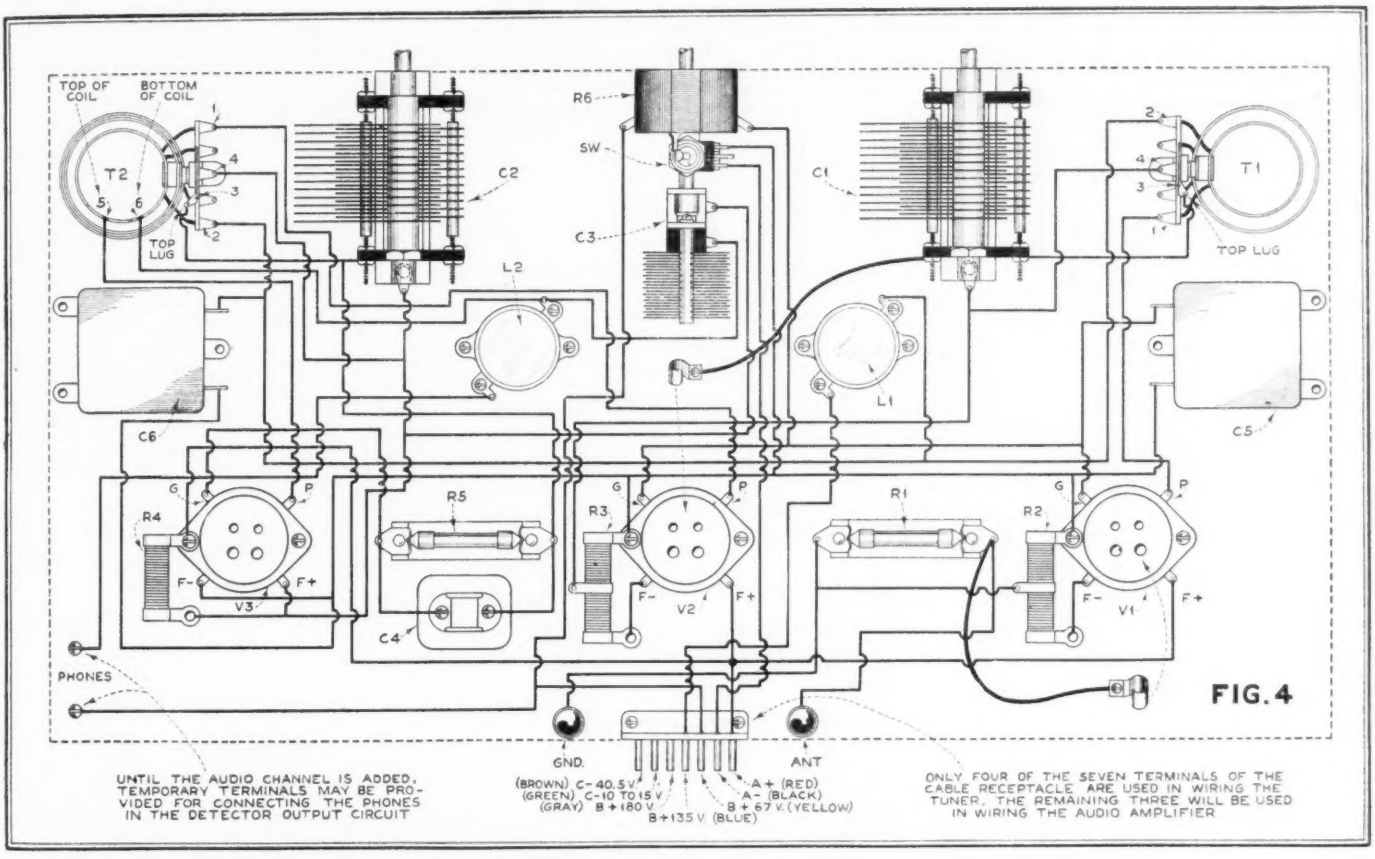


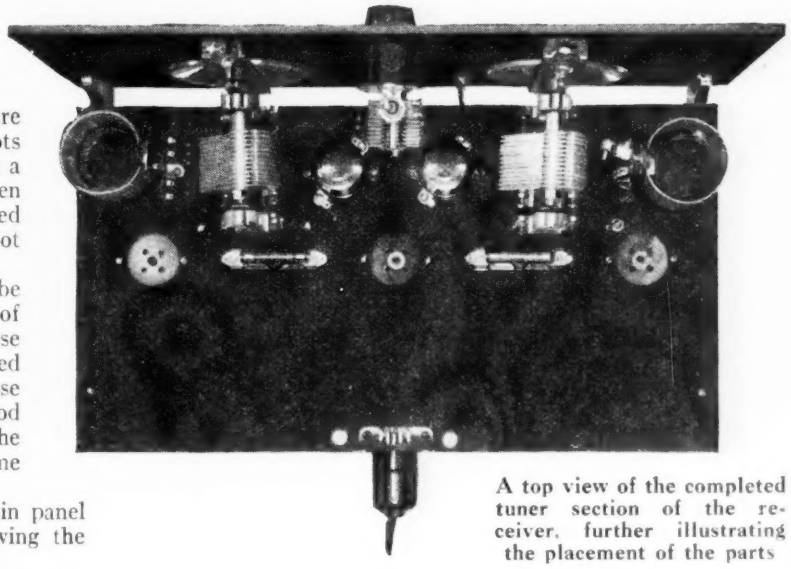
Fig. 4. Here is shown the actual wiring of the receiver, in picture diagram form. If you are unable to understand the circuit diagram of Fig. 1, the above layout will help you

room for the bottom of the tuning condensers which are mounted on the main panel. The sides of the slots should be cut with a hack-saw and the end drilled with a small drill, a row of holes made and then the piece broken out. A file applied to the rough edge thus produced will smooth it so that a clean-cut rectangular slot results.

The large holes which take the tube sockets cannot be drilled with a drill unless, in the same fashion, a row of holes is made on the inner side of the circumference of these circles, the piece broken out and the rough edge smoothed with a file. A better way to make these holes is to use a circle-cutter in a hand-brace. With this latter method a clean, more accurate hole is obtained than with the former method, with the added advantage that less time is taken in the drilling process.

After the sub-panel has been prepared, then the main panel may be laid out and drilled in a like manner, following the drilling details as outlined in Fig. 2.

Before assembly can be commenced one of the coils, that used between the second r.f. stage and the detector tube, must be altered. On a cardboard tube which will snugly fit inside

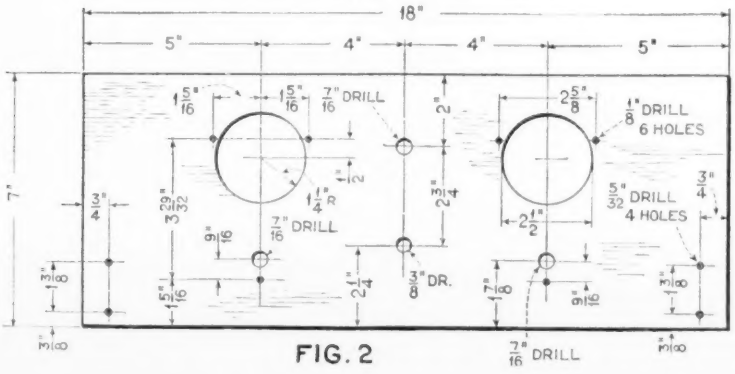


A top view of the completed tuner section of the receiver, further illustrating the placement of the parts

this coil, wind 25 turns of No. 24 d.c.c. wire, the turns of this new coil being wound in the same direction as the secondary coil. After it is wound it may be inserted within the secondary and fastened in place with a few drops of collodion, a cement-like substance obtainable at your drug store.

By means of brackets the two panels are joined together. Then, again studying the photographs, the parts are mounted on panel and sub-panel.

Fig. 2. The main panel should be drilled as shown in the panel layout below



Wiring

The circuit diagram, Fig. 1, and the picture wiring diagram, Fig. 4, give complete details of how the parts are to be wired together. As a test of your knowledge of symbols and circuits, it is recommended that you try to follow the circuit diagram, Fig. 1. For the inexperienced the picture diagram, Fig. 4, will prove helpful.

A solid, well-insulated wire should be used for wiring. Since most of these wires will be out of sight, underneath the sub-base, there is no need for the right-angle, square-cornered type of wiring merely to obtain a smart appearance. Point-to-point wiring is (*Continued on page 855*)

~RADIO NEWS HOME LABORATORY EXPERIMENTS~

WITH this issue RADIO NEWS inaugurates a new department, "Radio News Home Laboratory Experiments."

Each month a simple, easy experiment will be explained, so that by duplicating it the home experimenter may see for himself how various pieces of radio equipment and collections of apparatus function.

The subjects to be dealt with in this department will not follow any "text-book" order of presentation. Rather, timeliness will guide the editors in their treatment of the subjects covered.

Take, for instance, the first subject, "C Bias Resistors—Their Placement and Value." Set-builders and experimenters have taken for granted the information passed on to them by authors of articles wherein is described a receiver or amplifier, without knowing the "whys and wherefores" of certain design features. This is especially true of C Bias Resistors. The experiment explained here shows by actual practice how C bias resistor values are determined and where they should be placed in radio circuits.

Other subjects of a like nature will be treated in future issues. If you have any particular experiment you would like to have covered, write your suggestion to the "Home Laboratory Experiment" Editor, RADIO NEWS, 381 Fourth Avenue, New York City.

C Bias Resistors-Their Placement and Value

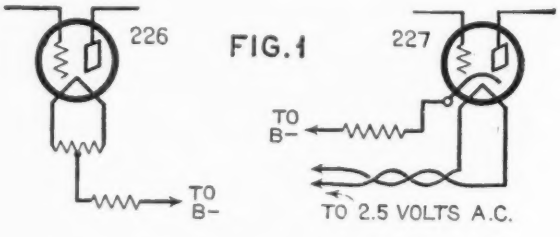
FEW resistors in a modern radio receiver are more important than those which serve to supply "C" bias to the various tubes in the set. Without these resistors or with units of the incorrect value the receiver will distort, the selectivity and sensitivity will be very poor and the life of the tubes will be shortened—a terrible list of ills indeed.

Now the correct value of the "C" bias resistor and its correct placement in the circuit are things not very difficult to determine, although they are likely to prove confusing to the experimenter, especially to him who has been accustomed to work with battery-operated sets where such things as "C" bias resistors are not encountered. Let's see if we can't get the low-down on this matter of "C" bias.

In Fig. 1 we show the circuit of a single -26 and a single -27 with the "C" bias resistors indicated in both cases. Note that in the case of the -26 the resistor goes between "B—" and the center-tapped resistor connected across the tube's filament. In the case of the -27 the resistor goes between the cathode of the tube and "B—." The "C" bias resistors in a modern set are *always* connected in this manner and in working out any particular problem these simple fundamental diagrams should always be kept clearly in mind. Just keep in mind that the resistor goes between "B—" and the cathode in the case of the -27, and between "B—" and the center-tapped resistor in the case of all other tubes used in an a.c. receiver.

Let us take an example. Suppose we want to hook up a single stage of audio amplification using a type -27 tube. Before actually doing the job a circuit diagram should be drawn. The first thing we do is draw out the elements of the -27 as indicated at A in Fig. 2, and label the various elements. G is for the grid, K is for the cathode, H and H are the heater terminals, and P is the plate terminal. The next thing we do is to draw in the two audio transformers T1 and T2, marking the four terminals as follows: P for plate, G for grid, F for the filament end of the secondary, and B for the plate battery end of the primary. As indicated at B, we connect the G of the transformer 1 to the grid terminal of the tube, and connect the P terminal of the transformer T2 to the plate of the tube. The next step is indicated at C, where we have added to the circuit by taking the two heater leads H, and have twisted them and made connection to a 2.5 a.c. source. The B terminal of T2 has been connected to "B+" of the plate supply, which would probably be a "B" power unit.

In diagram D we have completed the circuit. To do this we remember the previous rule that the "C" bias resistor goes between the cathode and "B—." So we just draw in a resistor, connecting one end of the cathode terminal K and the other end to "B—" There is only one other connection to make and that



is the lead to the F post of the transformer T1. Here we can state another rule. The leads which in a battery set would ordinarily go to the "C" battery are, in an a.c. set, always connected to "B—." And so, using this rule, we show a connection between F and "B—." And the diagram is completed and it's correct. Oh, we have neglected one thing. We should put a 1 mfd. by-pass condenser across the "C" bias resistor. It is generally a safe rule to by-pass the "C" bias resistor, although there are certain cases where by-passing is not essential.

Do You Know What Value of Resistor to Use?

How can the right value of the "C" bias resistor be determined? First let us see what we are trying to do. We placed the "C" bias resistor in the circuit to obtain the "C" bias voltage for the grid. The voltage which is available across the "C" bias resistor is due to the plate current of the tube flowing through the circuit. Now from any table of tube characteristics we can determine the plate current of any standard tube, and we can also determine what "C" bias the tube requires for its proper operation. Knowing these two facts gives us all the information we require to determine the value of the resistor. To calculate it we use Ohm's law, which states that

TUBE	GRID BIAS VOLTS		PLATE VOLTS	PLATE CURRENT (MA.)
199	1.5		45.0	1.0
	3.0		67.5	1.7
	4.5		90.0	2.5
120	16.5		90.0	3.2
	22.5		135.0	6.5
201A	1.5		45.0	.9
	3.0		67.5	1.7
	4.5		90.0	2.5
	9.0		135.0	3.0
240	3.0		135.0	.2
	4.5		180.0	.2
222 *	1.5		90.0	1.5
	1.5		135.0	1.5
	3.0		135.0	1.0
224 ‡	1.5		180.0	4.0
226	6.0		90.0	3.5
	9.0		135.0	6.0
	13.5		180.0	7.5
227	6.0		90.0	3.0
	9.0		135.0	5.0
	13.5		180.0	6.0
112A	D.C.	A.C.		
	4.5	7.0	90.0	5.5
	9.0	11.5	135.0	7.0
	10.5	13.0	157.5	10.0
	13.5	16.0	180.0	10.0
171A	16.5	19.0	90.0	10.0
	27.0	29.5	135.0	16.0
	33.0	35.5	157.5	18.0
	40.5	43.0	180.0	20.0
245	34.5		180.0	26.0
	51.5		250.0	32.0
250	45.0		250.0	28.0
	54.0		300.0	35.0
	63.0		350.0	45.0
	70.0		400.0	55.0
	84.0		450.0	55.0

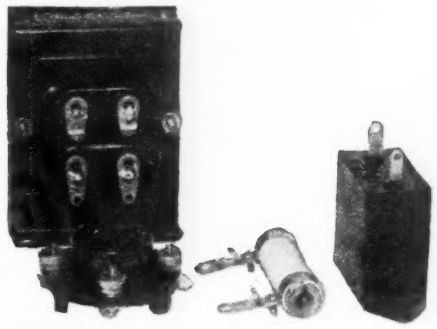
* SCREEN-GRID VOLTAGE +45
‡ " " " +75

Ohm's law states that

$$\text{The Resistance in ohms (R)} = \frac{\text{The Voltage in Volts (E)}}{\text{The Current in Amperes (I)}}$$

$$R = \frac{E}{I}$$

The voltage in this case is the "C" bias voltage which we determined by reference to the tube table. The current is the plate current of the tube similarly determined. The current, however, was probably expressed in milliamperes and for use in the



formula it must be in amperes. Well, an ampere is a thousand times larger than a milliampere, and so to change milliamperes to amperes we divide by 1,000. We then take the voltage and divide it by the current in amperes and the answer is the required value of the "C" bias resistor.

Here is a practical example. By reference to a tube table we find that a type -27 tube with 90 volts on the plate requires a "C" bias voltage of 6 volts and that the plate current is 3.0 milliamperes. Changing milliamperes to amperes, we get 0.003 amperes. That is,

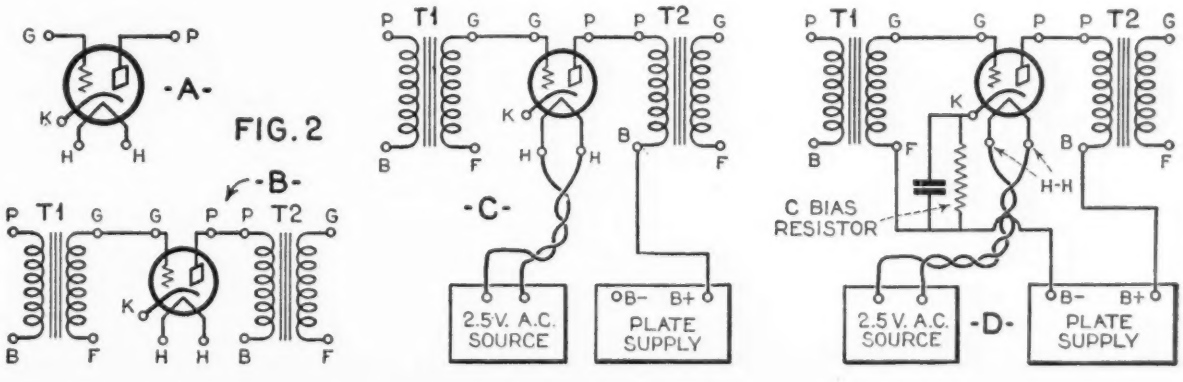
3 milliamperes equals 3 divided by 1,000 or 0.003 amperes

We can now use the formula given above

$$\text{The value of the "C" bias resistor} = \frac{6}{0.003}$$

R = 2,000 ohms, the value of the resistor.

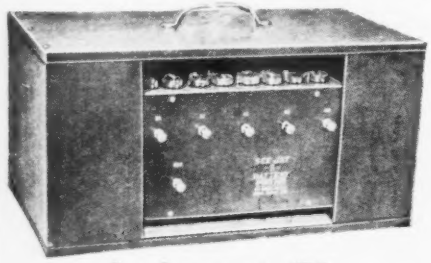
And so we have worked out together the two important points regarding "C" bias resistors—we have determined where they should be placed in the circuit and how their value is calculated. In doing it we have become acquainted with Ohm's law, one of the most useful and important laws of all electricity.



News FROM THE Manufacturers

A Compact "B" Battery

Despite the popularity of the a.c.-operated broadcast receiver there is a small army of radio fans to whom batteries are still the most popular source of "A" and "B" supply, according to the See Jay Battery Company, makers of Edison element storage "B" batteries.



See Jay storage "B"

Making use of the Edison elements, a number of cells are grouped in a walnut-finished cabinet to make up the standard See Jay batteries of 100-volt, 140-volt, 180-volt units. A small quantity of transformer oil floats on the surface of the

Edison elements

solution in each cell, preventing excessive evaporation, making it necessary to add water to the solution only every three months.

These storage "B" batteries may also be had complete with charging units for 110 volts a.c. or d.c., as well as 32-volt farm lighting plants. A special power unit is also available for the amateur and experimental short-wave transmitter enthusiast.

Another Antenna Substitute

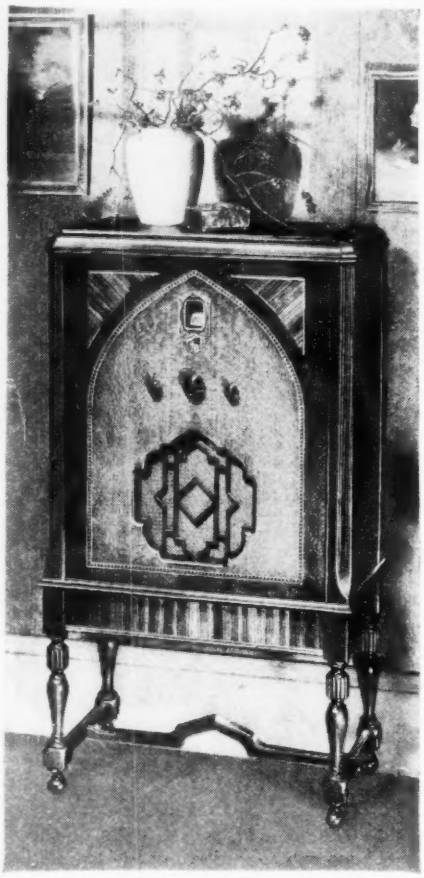
From the Wellston Radio Corporation comes the announcement of a new type of Gold Test Aerial which, according to their engineering staff, makes a set more selective, providing clearer tone quality

A compact indoor aerial

with less interference. This aerial is non-directional, and is claimed to have the equivalent capacity of a single wire aerial 54 ft. long and 50 ft. high. The complete unit is a small compact aerial, being only 2½ by 5 inches, small enough to be placed anywhere. Such an aerial is not connected with the lamp socket, eliminating a.c. hum interference as well as lightning hazards.

Bel Canto's New Addition

A new radio receiver, to be known as the "Minuet," has been added to the 1930 Bel Canto series, according to the Amrad Corporation. The new "Minuet" is a console of fine walnut and lacewood. The

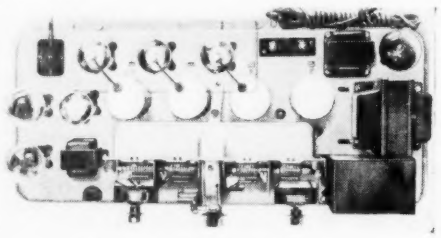


Minuet by Amrad

circuit makes use of eight tubes, including three screen-grid and –45's in push-pull, a Mershon condenser, an extra heavy metal chassis, and a nine-inch electric speaker mounted on a baffle board.

New Receiver Announced

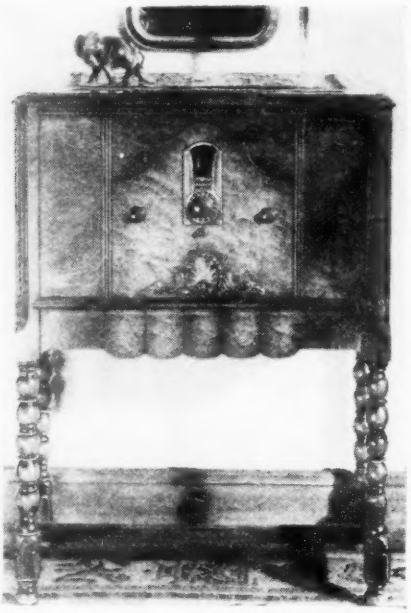
Two new chassis is the announcement from the Philco Company in the models 76 and 95. The model 76 consists of four tuned stages, including a tuned input circuit, with specially designed radio-frequency transformers, giving substantially equal amplification and selectivity throughout the broadcast frequency band. This model, as well as the other Philco chassis, has the balanced-unit construction, freedom from hum, and a local-distance switch. By utilizing a screen-grid detector, together with coil and shielding design in the radio-frequency amplifier, Philco engineers claim to be able to get sensitivity and distance range as high as has heretofore been had only in sets of greater number of tubes. The double-input circuit eliminates any possibility of cross-talk as well as reducing interference



Philco's balanced chassis

noises. Three –24 tubes are used in the radio frequency and detector stages of this model, with a –27 in the first audio and two –45's in the push-pull output stage, a –80 full-wave rectifier in the power pack.

In the 95 model three –24 tubes are required for the radio-frequency stages, two –27's as the detector tube and detector amplifier, with two –45's connected in the push-pull circuit, and a –80 rectifier. This model makes use of the automatic volume control and is known as the Screen Grid Plus.



A specially designed console which accommodates Philco's new chassis

For those residing in the 25-cycle power districts Philco has developed the model 92.

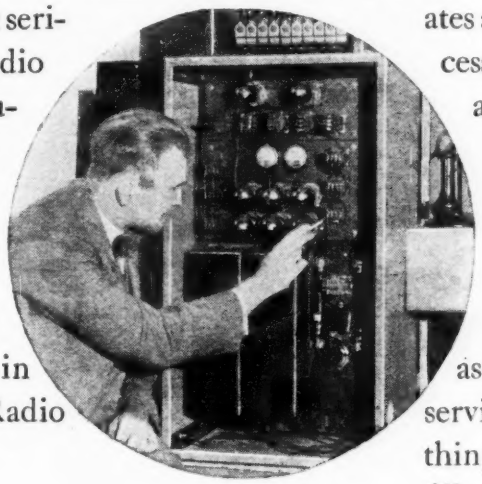
All the above models may be had in the new distinctive console, of matched butt-walnut side panels and a bird's-eye maple center panel, with walnut veneer sides and top. An entirely new feature has been incorporated in this new console

(*Continued on page* 856)

RADIO NEEDS YOU

Let RCA Institutes show you the way to SUCCESS in this fast-growing industry

REACH out for a big-pay job in Radio... Tie-up to the fastest-growing industry in the world today . . . See for yourself what other men have done . . . You, too, can do the same! Hundreds of fellows just like you are now earning from $2,000 to $25,000 a year in RADIO. J. H. Barron, Radio Inspector of the U. S. Department of Commerce says that a most serious shortage in trained Radio men exists right now. Thousands of trained men are needed. Broadcasting stations, manufacturing plants, retail and wholesale dealers, as well as ships at sea and planes in the air, require trained Radio men.



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The Radio Forum

A Meeting-Place for Experimenter, Serviceman and Short-Wave Enthusiast

The Experimenter

Efficient Socket-Power Operation

Do your tubes burn out after short use, the set overheat in a warm room,

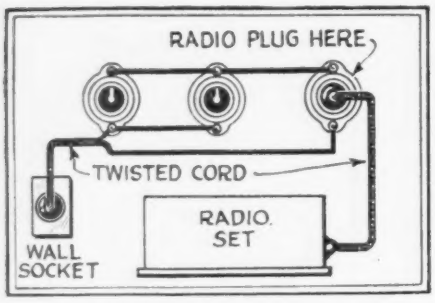
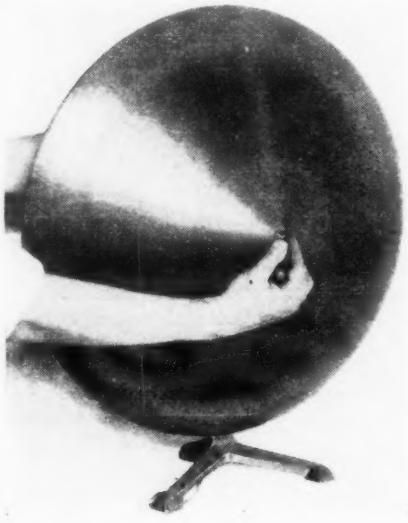


Fig. 1—Two lamps for current reduction

the power pack condensers or resistors burn out periodically? If so, you probably have an over-supply of a.c. line voltage, which, for the sake of economy and efficiency, should be reduced to a lower value, for which your receiver has been designed. Manufacturers generally hold to the belief that radio set users, experimenters and servicemen can be depended upon to make line-voltage adjustments, in consequence of which the majority of radio receivers do not include such voltage regulators in their equipment. Nevertheless, the need for properly adjusting radio receivers so they will operate under varying conditions is essential.

When a batteryless radio receiver is operated in a locality where line voltage is consistently above normal, the life of the tubes is not only reduced but there is great likelihood of burn-outs in the power pack equipment. If the line voltage is below normal, it is not possible to correct this condition unless the set is designed with taps to the input of the power transformer, which, of course, will provide the proper adjustment for compensating the lack of sufficient line voltage. The proper way to determine whether the line voltage is above or below normal is by the use of an accurate voltmeter. If there is reason to believe that the voltage is too high, it is easy to determine, even though an a.c. voltmeter is not available. One method, although somewhat crude, of determining whether the receiver is operated at excessive voltages is to note the brilliancy of the tube filaments. The oxide-coated filaments, such as used in a number of present-day power tubes, should be only dull red and in a majority of cases will be visible only in a darkened room. If the filament shows either a cherry red or straw color, then it may be taken for granted that a line voltage-regulating device is necessary, in which case one may make a choice of several different line control devices known as voltage control boxes and which may be obtained from any radio store listing from $2 to $10 per unit. The more expensive ones are equipped with a.c. voltmeters to enable the user accurately to check the voltage.

For the experimenter who wishes to construct his own devices with only a small investment, a ballast lamp is the best to use. Such a lamp has been used in some commercial sets and is marketed as ballast lamp –76 and –86. Of course,



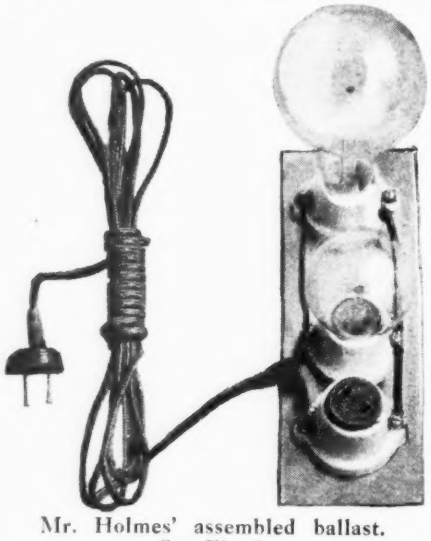
If one wishes to obtain the best in tone quality and volume from a cone speaker, it is necessary to make frequent adjustments to the set screw in the apex of the cone. Such adjustments are required to overcome the warping of the cone surface caused by the temperature and atmospheric changes in the average home. Warping of the cone surface forces the driving pin out of line and results in tinny or "muddy" quality with an appreciable loss of volume

the home experimenter will of necessity need to use somewhat smaller capacity ballast lamps, and, according to Mr. H. M. Holmes, Pasadena, California, the conventional type of incandescent lamp fits in ideally with this requirement.

The following arrangement of parts will serve the purpose of an experimental ballast lamp assembly: three porcelain lamp receptacles, six feet of lamp cord with plug attached and assortment of lamp bulbs including the following sizes: 100, 75, 50, 25 and 15 watts. With this assortment of material, one can proceed to construct the unit as shown in Fig. 1.

When mounting the assembly in a console cabinet it will be best to mount directly on the interior of the cabinet, providing a space can be found adequately large to house the complete assembly; otherwise, the assembly may be placed beneath the table or behind some piece of furniture. Following are some operational hints that may be found of advantage:

Insert the 75-watt lamp and if it lights brightly, a larger lamp or lamps will be required. The correct brilliancy will be approximately one-half their normal or less. When this has been obtained, tune in a local broadcasting station and note the tone quality. If impaired, it is in all likelihood caused by some defective tube or tubes which were not noticeable when operated at a voltage above normal. For all-around economy, it is best to use the smallest set-up of lamp bulbs that will produce good tone, selectivity and sensitivity. The light bulbs not only increase the life of your radio equipment but also act as a safety device. In case of a short or a breakdown in the set, the lamps light up brilliantly, warning the experimenter, thus saving the rest of the equipment in his receiver, and also enabling him to check repairs on the set without blowing fuses.



Mr. Holmes' assembled ballast. See Fig. 1

Using Phones Instead of a Speaker

"It is undesirable for more reasons than one to tune for distant stations late at

(*Continued on page* 854)

THE above clipping was a leading editorial in one of the principal magazines devoted to the radio industry. It is of vital interest to anyone connected with the sale of radio.

The De Forest Radio Company fully agrees that the future of Radio depends to a large degree upon the excellence of tubes supplied to dealers and to set users. The responsibility is squarely up to tube manufacturers.

For years De Forest Audions have set the world's standard of excellence. They contain less than one-fifteenth the air pressure of other standard makes. The degree of vacuum is directly responsible both for the life and for the operating qualities of a radio tube.

De Forest Audions are subjected to more rigid tests and inspections than any radio tubes on the market. Before a De Forest Audion is permitted to leave the De Forest Laboratories it is as nearly perfect as it is possible to make a radio tube. It is as accurate and dependable as a fine watch.

While all radio tubes are licensed under patents controlled by the De Forest Radio Company, De Forest Audions contain many individual refinements of filament design, improved chemical processes and more rigid mechanical construction. Thus every De Forest Audion is equipped to reduce the staggering total of service calls and dissatisfaction now traceable to inferior tubes.

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The Serviceman

A Low-Cost Tube Tester

The serviceman as well as the experimenter undoubtedly has often wished for a tube tester that would test all tubes, but has balked at buying one when he learned the prices. Undoubtedly, the following instructions by Mr. J. E. Denies of Topeka, Kans., will be of interest.

The parts for this tester can undoubtedly be obtained from the junk box of the average radio fan. Let us start with the filament transformer. The one used by Mr. Denies was made from an old potential coil taken from a GEI 14 watt-hour meter, but if such a meter is not available, the dimensions shown in Fig. 1 will be satisfactory. The 110-volt or primary winding is wound with 660 turns of No. 28 enamel wire insulated between wires with thin oiled paper. The secondary winding is of 45 turns of No. 16 cotton enamel wire tapped at the 9th, 15th, 18th, 30th and 45th turns. These are connected to a tapped switch on the panel on the first, third, fifth, seventh and ninth taps, leaving a dead point in between each of the alive taps, so that the switch arm will not short the transformer when changing filament voltages.

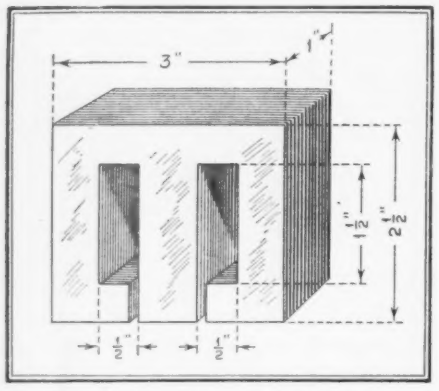


Fig. 1—Transformer laminations

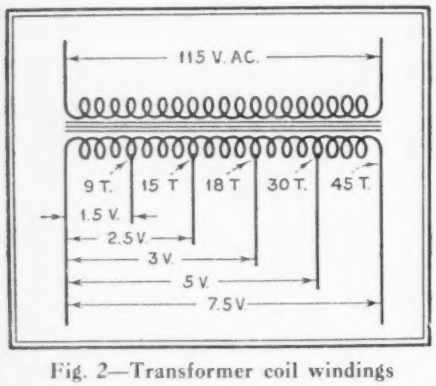


Fig. 2—Transformer coil windings

Fig. 2 is a schematic diagram of the transformer windings. It is realized, of course, that the builder of such a test unit as here described will probably have his own ideas as to how the apparatus should be mounted on the panel, for ease in operation. A panel layout, therefore, is not shown. In the circuit diagram, Fig. 3, it will be seen that the filament terminals are connected in parallel and by means of a tapped switch, voltages of 1½, 2½, 3½ and 7½ can be had. These, however, should be plainly marked to prevent tube burn-outs. The milliammeter A has a full scale deflection of 10 mils, and is shunted with the resistance R1 of 900 ohms, tripling the scale reading. R2, a 50-ohm center-tapped resistor, is connected across the filaments, the center tap going to two resistors, one being 500 ohms, R3, and R4 of 3,500 ohms. These resistors provide an automatic "C" bias. Shorting the resistor R4 by means of the switch SW2 changes the "C" bias from 4 volts to 1½ volts.

Screen-grid adaptors can be made up easily by using old –27 and –01A bases and a 5-prong subpanel socket as well as a 4-prong subpanel socket. Cut off the contact screws so as to give as much clearance as possible in connecting the head of the adapter to the base, running a small diameter bolt through the assembly, holding them together. A flexible wire up to the control grid of the tube completes the mechanical features. After a little practice with this tester, anyone can determine the efficiency of all tubes and do it quickly. For the beginner, the table given below provides a starting point on standard tubes:

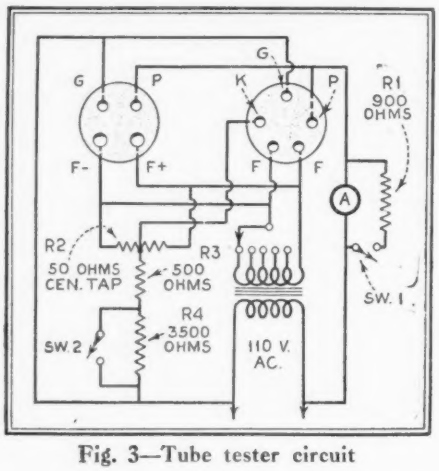


Fig. 3—Tube tester circuit

Type	*Low Reading*	*High Reading*	
–10	2	6	
–27	1	6	
–26	2	8	
–71	2	8	(with shunt)
–12	2	10	
–45	2	9	
–99	1	4	
–80	2	10	(with shunt)
–24	1	5	
–22	2	8	

For the benefit of those who have not as yet a complete "junk box," the following list of parts may be used as a guide:

1 Pilot 5-prong subpanel socket
1 Pilot 4-prong subpanel socket
1 Pilot 4-prong insulated socket
1 Pilot 5-prong insulated socket
2 Pilot panel-mount toggle switches
1 Readrite 10-mil. milliammeter
1 7 x 7 panel
1 50-ohm center-tapped resistor
1 900-ohm 25-watt resistor
1 500-ohm 25-watt resistor
1 3,500-ohm 25-watt resistor
1 tap switch
1 5-prong tube base
1 4-prong tube base
Parts for transformer
Wire for transformer and hook-up
Lamp cord and attachment plug

Power Pack Servicing

Due to the relatively few component parts, the detection of defective apparatus in a power pack is not a hard problem. The possible causes of trouble may be roughly classified as defective power transformer, rectifier tube, chokes, resistors and condensers. The simplest form of voltmeter-battery test will disclose whether there is a burn-out or short circuit in any of the above-mentioned components, and their replacement is likewise a simple matter, with, perhaps, the exception of the filter condensers. Here the greatest care is required.

A broken-down filter condenser is easily discovered. Generally this condition is indicated by the plates of the rectifier becoming excessively hot. The condenser block should be unsoldered and disconnected from the circuit and a battery voltage applied. The condenser terminals should then, two by two, be short circuited immediately after the charge is applied, and a small spark should result. If the spark does not materialize the condenser is defective and requires replacement. Great care should be taken in testing power packs, as high voltages are developed across the terminals, and unless these charges are dissipated before testing, a bad shock may be received.

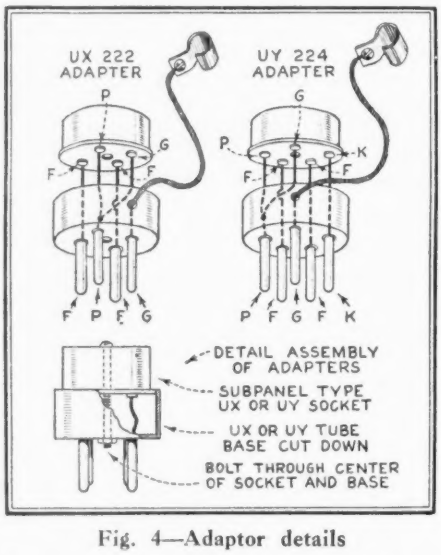


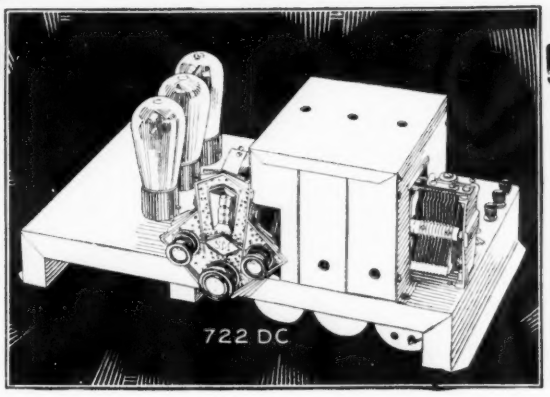
Fig. 4—Adaptor details

According to Harry W. Houck, chief engineer of the Dubilier Condenser Corporation, the testing and replacement of condenser blocks is the most delicate operation in the servicing of a power pack, and should not be undertaken unless the smallest of soldering irons and the steadiest of hands are possessed. "Faulty soldering will destroy or at least weaken a paper condenser quicker than any other factor aside from excessive

(*Continued on page* 848)

SM

New 722DC Custom Design Easily Tops Battery Set Market



A "Bearcat" for Battery Operation

Selectivity that will cut through powerful locals, DX ability that will keep you up all night, and tone quality that is limited only by the speaker itself—that's the kind of a set S-M's new screen-grid, battery-operated 722DC is! It's a fitting companion to the all-electric 722—and for only $57.50, completely wired, less tubes.

Average loud-speaker reception is from five hundred to two thousand miles—from 30 to 60 broadcasting stations in a single evening! It has a built-in power unit; four tuned circuits (including a band-selector used as an antenna coupler); very smooth volume control; two 12A tubes in push-pull—in fact such an ideal combination that its possibilities are almost unlimited. If you must use batteries, there's no receiver to compete with the new S-M 722DC (illustrated above).

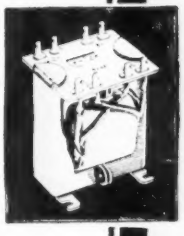
Tubes required: 3—'22, 3—'12A. Wired, less tubes, $57.50. Parts total $38.50.

Band-Selection at Its Best!

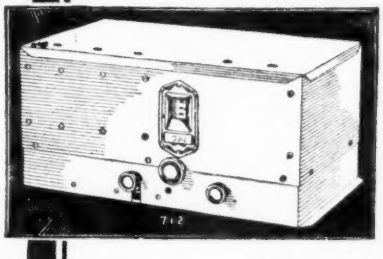
The S-M 722 (a.c. operated with built-in power supply), with its ability to out-perform receivers many times as costly, is unquestionably the best screen-grid "buy" on the custom market today. Two stages of r.f. amplification, screen-grid power detection, two '45 tubes in push-pull, four tuned circuits (two in a band-filter between antenna and the first r.f. stage and two in cascade), individually by-passed circuits, individually shielded coils, r. f. and detector tubes—these are some of the features that permit the 722's outstanding performance.

The a.c. 722 uses 3—'24 tubes, 1—'27, 2—'45, and 1—'80. Wired, less tubes, $74.75. Parts total $52.90. Beautiful 707 cabinet (fits 722, 722DC, or 735), $7.75.

New 249 Filament Transformer



The S-M 249 Filament Transformer, a companion to the 247, meets exactly the requirements of modern receivers using heater and '45 type tubes. The center-tapped secondary (2.5 volt, 3 amp.) is for use especially with '45 tubes, and another 2.5 volt winding will supply 9 amp. for 5 heater type ('27, '24) tubes. Ratings are conservative: 50 per cent overload permissible for short intervals. Price, $3 net.



For the Most Stations and Best Reception—S-M 712

The S-M 712 Screen-Grid Tuner, in its battleship shielding cabinet (illustrated), is absolutely guaranteed to out-distance and out-perform all competition regardless of price—and at only $64.90 wired, complete, less only tubes. It utilizes 3—'24 tubes in three stages of r.f. amplification followed by a '27 power detector.

Priced, wired, $64.90. Parts total $40.90.

Any good audio amplifier can be used with the 712—the ideal combination, however, is attained when it is used in conjunction with the S-M 677. Operating power is obtained from any 105 to 120 volt, 60 to 50 cycle source. Tubes required: 1—'27, 2—'45, 1—'80.

S-M 677 priced complete, less tubes, $58.50. Parts total $43.40.

Short-Wave and Broadcast

The way the little *all-electric* short-wave 735 Round-the-World Six will pick up stations is "nobody's business"! The first set of its type offered the amateur and broadcast listener—it is without question the finest.

Tubes required: 1—'24, 2—'27, 2—'45, 1—'80. Priced, wired, $64.90. Parts total $44.90. Extra broadcast band coils cost $1.65.

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..... No. 6. 740 "Coast-to-Coast" Screen Grid Four
..... No. 7. 675ABC High-Voltage Power Supply
..... No. 8. 710 Sargent-Rayment Seven
..... No. 9. 678PD Phonograph-Radio Amplifier
..... No. 12. 669 Power Unit
..... No. 14. 722 Band-Selector Seven
..... No. 15. 735 Round-the-World Six
..... No. 16. 712 Tuner (Development from the 710 Sargent-Rayment)
..... No. 17. 677 Power Amplifier for use with 712
..... No. 18. 722DC Band-Selector Six

Name.....

Address.....

(*Continued from page* 846)

voltage or electrical strain," declares Mr. Houck.

For the soldering of condenser sections, small soldering irons should be used and these must be kept clean and bright. Resin should be used to clean the parts and just enough heat applied to do the job in a minimum of time; for, if the soldering iron is applied for too long a time, the heat causes the impregnating compound of the condenser to melt. The solder may even work its way down into the tightly wrapped paper and tinfoil, causing a short circuit or weak spot. Acid soldering flux or paste should never be used, for while it is easier to apply and solder, the slightest trace of acid may result in chemical action, deterioration, weak spots and even an open connection chewed away by the acid. No acid soldering flux is permitted in the Dubilier plant, and none should be employed outside.

Despite the greatest care taken in the manufacture and assembly of condenser sections, there is always the danger of improper soldering by the serviceman or individual making repairs. To avoid this trouble condensers should be so constructed that the terminals are quite removed from the actual condenser section, so as to prevent conduction of the heat from the soldering iron to the delicate condenser itself. In this respect the latest condenser blocks with flexible leads or pigtails represent not only greater convenince in wiring, but also eliminate to a large extent the danger of ruining the condenser in soldering.

On Short Waves

Meters vs. Kilocycles

For certain reasons it is more desirable, writes Mr. F. S. Saunders, of Bath, Maine, to rate short-wave broadcast stations in terms of frequencies rather than wavelengths. This practice naturally confuses many short-wave fans, for to them kilocycles and meters are in no way related, but such is not the case, since they have a very definite relationship to each other.

To understand thoroughly these terms, one must remember that radio waves travel at the same velocity as light, or approximately 186,300 miles per second. The wavelength of one meter is, therefore, 3,000,000 cycles per second, or more commonly called 300,000 kilocycles, one kilocycle, of course, being equal to 1,000 cycles.

Simply divide 300,000 by the wavelength in meters and the result will be the frequency in kilocycles, or in other words, the short-wave station of the General Electric Company at Schenectady, N. Y., W2XAF, broadcasting on a wavelength of 31.40 meters, uses a frequency of approximately 9530 kilocycles. The result being obtained by dividing 300,000 by 31.48. The resulting frequency being 9530. Likewise, 300,000 divided by the frequency in kilocycles will give the wavelength figure as an answer.

Frequencies which are below 10,000 are usually termed as "audio" by virtue of their being audible to the human ear. Frequencies above the 10,000 cycle band are usually termed "radio frequency" and except in rare cases are not audible. Signals at radio frequencies are received on our antennæ and not until they are rectified—or changed—by the detector stage is one able to enjoy the modulation placed on the broadcast wave, which is simply another way of referring to the program itself.

Wide World Photos

To Miss Ruth J. Peiser, W6OK, of San Francisco, California, is given credit for being the first girl in the state of California to obtain an operator's and station license. Miss Peiser, a graduate of the radio school in San Francisco, is shown here at her short-wave receiver. The transmitter is to the right

Radio Movies on 1604 KC.

At the top of the dial on the short-wave receiver there is a new station to be tuned in. It is W2XCD, the experimental radio-telephone station of the DeForest Radio Company, Passaic, N. J. Recently station W2XCD inaugurated its program, using 50 watts, reception being reported of good loud speaker volume and excellent tone quality as far as Philadelphia. It is reported, however, that the power of this station is to be increased to 5,000 watts output under the new license granted by the Federal Radio Commission. Every evening from 8 to 10 P. M., Eastern Standard Time, this station broadcasts on a frequency of 1604 kilocycles (187 meters). In the near future W2XCD is to be used to transmit the vocal and sound accompaniment for the Jenkins radio movies or radio vision pictures transmitted from W2XCR of Jersey City. The combined reception of sound and sight signals at the home end by means of a standard broadcast or short-wave receiver and the special radio vision equipment will constitute synchronized sound pictures or radio talkies. It is interesting to note that there are at present ten different makes of standard broadcast radio receivers capable of tuning in the signals of W2XCD on 187 meters.

A Letter From Lithuania

Editor Short waves: Your esteemed journal, RADIO NEWS, in its September number published the list of all the radio broadcasting stations of the world and information on the subject of the Kovno (Kannas) post was incomplete. I am offering for your use the actual data concerning our Lithuanian station.

(*Continued on page* 875)

A Radio Dream Come True

(*Continued from page* 785)

it was an old military barracks. It was in a room of this building that I set up my receiving apparatus in preparation for the great experiment.

On Monday, December 9th, barely three days after my arrival, I and my assistants began work on Signal Hill. The weather was very bad and very cold. On the Tuesday we flew a kite with 600 feet of antenna wire as a preliminary test, and on the Wednesday we had inflated one of our small balloons, which made its first ascent during the morning. Owing, however, to the strength of the wind, the balloon soon broke away and disappeared in the mist. I then concluded that perhaps kites would answer better, and decided to use them for the crucial test.

I had arranged with my assistants in Cornwall to send a series of "S's" at a prearranged speed during certain hours of the day. I chose the letter "S" because it was easy to transmit, and with the very primitive apparatus used at Poldhu I was afraid that the transmisison of other Morse signals, which included dashes, might perhaps cause too much strain on it and break it down. Mr. Entwisle, Mr. George and Mr. Taylor were in charge of the English station at Poldhu during the transmission of signals to Newfoundland.

On the morning of Thursday, the twelfth of December, the critical moment for which I had been working for so long at last arrived, and, in spite of the gale raging, we managed to fly a kite carrying an antenna wire some 400 feet long. I was at last on the point of putting the correctness of my belief to the test! Up to then I had nearly always used a receiving arrangement including a coherer, which recorded automatically signals through a relay and a Morse instrument. I decided in this instance to use also a telephone connected to a self-restoring coherer, the human ear being far more sensitive than the recorder.

Suddenly, at about half-past twelve, a succession of three faint clicks on the telephone, corresponding to the three dots of the letter S, sounded several times in my ear, beyond the possibility of a doubt.

I asked my assistant, Mr. Kemp, for corroboration if he had heard anything. He had, in fact, heard the same signals that I had.

I then knew that I had been justified in my anticipations. The electric waves which were being sent out into space from Poldhu had traversed the Atlantic, unimpeded by the curvature of the earth which so many considered to be a fatal obstacle, and they were now audible in my receiver in Newfoundland!

I then felt for the first time absolutely certain that the day when I should be able to send messages without wires or cables across the Atlantic and across other oceans and, perhaps, continents, was not far distant. The then enormous distance, for radio, of 1,700 miles had been successfully bridged.

On the following day the signals were again heard, though not quite as distinctly. However, there was no further doubt possible that the experiment had succeeded.

(*Continued on page* 850)

A Radio Dream Come True

(*Continued from page* 849)

The result was much more than the mere successful realization of an experiment. It was a discovery which proved that, contrary to the general belief, radio signals could travel over such great distances as those separating Europe from America and it constituted, as Sir Oliver Lodge has stated, an epoch in history.

It must be remembered that at that time there was no suggestion of the existence of the Heaviside-Kennelly layer, nor of the reflection of electric waves from the higher regions of the atmosphere. The instruments we had at our disposal were very crude compared with those we have today. We had no valves or tubes, no amplifiers, no sensitive superheterodyne sets, no directional transmitters and receivers, and no means of making continuous waves. All we had for transmitting was the means of making crude damped waves by means of irregular spark discharges. The receivers that were then employed were insensitive as compared with those of the present day.

Following the success of the test I was promptly notified by the Anglo-American Telegraph Company that, as they had the exclusive right to construct and operate stations for telegraphic communication between Newfoundland and places outside that colony, the work upon which I was engaged was a violation of their rights. I was asked to give an immediate promise not to proceed with my experiments and to remove my apparatus or legal proceedings would be taken. I was absolutely astounded by this communication, which, however, at least gave me the satisfaction of knowing that one of the great cable companies not only believed in my success but feared the competition of radio trans-Atlantic communication.

I mention this to show why my experiments in Newfoundland were thus cut short. When, however, the reason became known, I received a very cordial invitation from the government of Canada to erect a station in Nova Scotia, an offer which I gladly accepted.

The announcement that I had succeeded in transmitting radio signals across the Atlantic was received with scepticism by most scientists, principally in Europe. The same thing cannot be said of American electrical engineers, for the American Institute of Electrical Engineers was the first technical and scientific body which believed in me and my statement of having received signals across the Atlantic Ocean. It was the first distinguished and authoritative society enthusiastically to celebrate the event and to extend to me its generous support and valuable encouragement. It celebrated the occasion by a dinner given to me in New York, at which most distinguished American scientists took part, including men whose names were and still are household words in electrical science, such as Dr. Alexander Graham Bell, the inventor of the telephone, Professor Elihu Thomson, Dr. Steinmetz, Dr. Michael Pupin, Mr. Frank Sprague, and many others. In less than three months from the date of the tests to Newfoundland these long-distance results were more than confirmed by experiments carired out by myself on the S.S. *Philadelphia* of the American Line.

Spanning great distances is now child's play compared with what it was then. The 1-beam projector and other commercial radio telegraph and telephone stations are now exchanging daily hundreds of thousands of words between distant parts of the earth. Wireless telephony over world-wide distances is now a reality, together with transmission of pictures, and the day is approaching when television will also be a commonplace. It may even be that the transmission of power over moderate distance may be developed in the not far distant future. I must leave to your imaginations the uses which can be made of these new powers. They will probably be as wonderful as anything which we have experienced so far.

Mr. Kemp and Mr. Paget are with me at the microphone today while I am addressing you, and I wish to send my most cordial greetings to all those interested in radio in America (I feel sure they form the majority of the American people) and to all my friends at the other side of the Atlantic.

A New Tool for the Serviceman

(*Continued from page* 808)

meter ranges are indicated in Fig. 4. Binding posts were placed at point "m." These binding posts are short circuited during normal use. If, however, we wish to cover a range such as 0–.1 volt with a full-scale deflection, the jumper is removed and a zero to two hundred microammeter substituted.

Since this meter can be used on either a.c. or d.c., we may calibrate on d.c. and use it on a.c. A distinct advantage of the method used to multiply the range is that it can be calibrated at any one range and will then be accurate for all ranges. It is of course understood that the input resistances should be exact in values. A good d.c. voltmeter of convenient range may be used in calibrating.

The finished instrument will come in handy in any experimental laboratory where an exact knowledge of circuit behavior is desired. It can be used to measure the gain of audio amplifiers, radio amplifiers, total gain of sets, loud speaker performance, microphone characteristics, and for a great many other measurements. Through its use we can find out how an amplifier behaves at different frequencies and with different circuit characteristics.

A future article will explain how some of these measurements can be made.

Canned Programs

(*Continued from page 815*)

of arranging special programs for radio on records and releasing them to the stations for their sustaining programs. He further experimented with long playing records and finally perfected one that plays thirteen minutes, thus eliminating the necessity of using seven ordinary ten-inch records to the half hour. The long playing disc is sixteen inches in diameter, and only two are used for a half hour program. This simplifies the procedure of transcribing the program at the radio stations.

When these programs are played at the station, the announcer tells the radio audience that the program is coming to them by "electrical transcription." This method of informing the public has been heartily endorsed by the Federal Radio Commission.

The system known as "spot" broadcasting, or the broadcasting of programs in "spot" markets or local cities, supplied the necessary link in radio advertising to make it as flexible as advertising of the printed word, and it has several inherent advantages over chain broadcasting. Some of them are:

1. The time element is completely eliminated, whereas when a program is put on the chain from New York at eight o'clock in the evening, the same program is heard on the Pacific Coast at five o'clock, due to the three-hour difference in time between the Pacific and Atlantic Coasts.

2. An advertiser using broadcasting can use any station in any city that he may desire, instead of having to engage the facilities of a certain group of stations connected on the chain. He has perfect flexibility, and can choose any market that he may desire in which to exploit his product via radio.

3. Many high-salaried performers of outstanding reputations are not always available during the hours most desirable for radio broadcasting. The recorded type of broadcasting makes them available, inasmuch as they can be recorded at their convenience and the program released for broadcasting at any time.

4. A complete year of broadcasting can be recorded in two weeks, and the artists can be engaged for the concentrated period, instead of being hired for an entire year. Their presence is not even required in one city for the entire period of the broadcast contract. In that way a financial saving is effected.

5. A small advertiser can start with small facilities and only a few stations, instead of being required to begin with a basic network consisting of from twelve to twenty stations before he can go into a national radio campaign. The small advertiser can increase his facilities as he desires and add stations as he needs them!

This system of broadcasting can be favorably compared with that of the printed word. There are two forms of advertising in use today: national, as exemplified by the magazine and trade papers, and "spot," as exemplified by the newspapers in different cities. A large amount of money is spent in both forms of advertising. We may compare chain

(*Continued on page 852*)

Canned Programs

(*Continued from page* 851)

broadcasting with the magazines and call it national radio advertising, and the recorded programs with the newspapers in each city and call it "spot" radio advertising. This gives us a fair picture of the part which recorded programs play in the radio advertising structure. Over twenty million dollars worth of national advertising was handled last year by the chains, and according to our comparisons there should be an equal amount of money available for spot radio advertising.

Many large manufacturers are today contemplating the use of this service in the belief that it may solve their merchandising problem from the standpoint of dealer cooperation and sales promotion. Heretofore a practicable way for cooperating through radio advertising with the individual dealers in each market was lacking. Many concerns aid the dealers by setting aside money for local advertising, if the dealer cooperates by spending some of his own for the same purpose. This can now be done in the radio field, since a manufacturer can pay for the making and recording of the program, and can send it to dealers in any city in which a radio station is located. The dealer in turn purchases the time from the local radio station, and sponsors a program of his own in behalf of the manufactured product. The talent and facilities are provided for by the manufacurer, who also pays for the station time.

A word about the method and procedure of this system may be of interest. After the program is arranged and recorded, the pressings are sent to the station approximately two weeks in advance of the broadcast. The station is equipped with a transcribing machine which is connected directly to the amplifier or panel of the broadcast station, thus eliminating the use of the microphone. The transcribing machine is similar to the ordinary phonograph, except that it does not contain a speaker. The record revolves at a slow speed of 33 1/3 revolutions per minute as against 78 revolutions per minute of the ordinary phonograph turntable. It has a pickup which is fed into the station amplifier, and from there sent to the transmitter of the station and over the air.

Radio Religion

(*Continued from page* 824)

employed uses three stages of amplification with a switching arrangement by means of which one of the stages can be cut out. In this particular installation this stage is never used, leaving only one stage of audio and one push-pull stage which employs Western Electric tubes with power rating approximately equivalent to the standard of the 210. The amplifier has a two position input, which means that it is intended for use with two microphones. Because of the necessity for four microphones in the St. Bartholomew installation, three of the microphones are connected in a single position to one of the input branches of the amplifier, whereas the fourth connects into the second position. The output transformer of the amplifier is provided with a number of taps for use with a number of speakers of varying power requirements. The amplifier is a compact unit mounted in a carrying case and is shown in one of the accompanying illustrations.

There is no separate speech amplifier, but instead the microphone leads, in the form of lead sheathed cable, are carried from the microphones to the amplifier (which is installed in the rear of the church). At the rear of the rostrum there is a microphone selector switch by means of which the particular microphone in use is cut in on the amplifier. In the amplifier there is another switch which can select either one of the two microphone positions, but this of course cannot select one from among the three microphones connected into one position. Volume is controlled at the amplifier. Because of the tapped output transformer which provides different volume levels there is no need for individual volume control at the speakers.

All of the output wiring between the amplifier, loud speaker and headphones is carried in "BX" (flexible metal covered pairs).

The accompanying illustrations show the layout of this installation, including the location of two of the microphones. The other two do not appear in the photograph.

St. Bartholomew's Church can hardly be considered as a typical one because of its unusual size, but it has been described here as an example of the many varying applications of amplifier systems.

Another installation suggesting some interesting possibilities, particularly for chapels and small churches in which the cost of a large organ would be prohibitive, is found in the mortuary chapel of A. E. Long & Sons, Undertakers, Cambridge, Mass. This chapel, shown in one of the illustrations, is of unusually pleasing design, but unfortunately does not provide space for a suitable organ. Also, speakers find it difficult to make their voices carry to a balcony located at the rear of the chapel. A Samson PAM-16 amplifier and MIK-1 speech amplifier constitute the amplifier system installed in this chapel. A giant dynamic loud speaker was mounted within a recess in the wall at the front of the chapel behind a large ornamental grille. This can be seen at the left of the pulpit. Two other speakers were installed in the balcony and a microphone working through the speech amplifier was mounted on the pulpit. The large speaker near the pulpit is used exclusively for the reproduction of phonograph recordings of organ selections, thus providing the advantages of an organ without the requirements of space and expense which would be involved in an actual organ installation. The speakers in

Radio Religion

(*Continued from page* 852)

the balcony are not required for reproduction of organ music to fill the chapel. When the microphone is used it carries the speaker's voice to the balcony, and it is for this purpose that the speakers were installed there.

This interesting and highly practical amplifier installation was made by the Gravelin Radio Service of Springfield, Mass.

In making comparatively small amplifier installations, as in dancehalls, restaurants and similar locations, the installation man will sometimes find it more convenient to employ a standard receiver amplifier combination than to use a separate tuner and external power amplifier. There are several standard receivers now on the market with an output power rating more than enough for most requirements. These receivers employ a push pull output stage, using two type -50 tubes, providing sufficient power to drive from three to ten dynamic speakers, depending on the volume required from each. Some of these standard receivers are also equipped with phonographic pick-up and turntable so that within one cabinet they incorporate all of the requirements for the successful combination of radio, phonograph and amplifier.

In many cases, of course, such a combination is not highly practical, because there is no necessity for the outfit being set up where it will be visible to the public, and therefore there is no need for the ornate cabinet which simply adds to the cost without providing any definite advantages. However, in many instances the dance hall owner, or restaurant keeper, may prefer to have the equipment installed in a public place in order to impress customers.

One interesting combination which is obviously suitable to meet this last requirement is the Leutz "Silver Ghost" console illustrated in this article. This combination is an extremely impressive one, being made up of a number of shielded sections with phonograph power amplifier and loud speaker, all mounted in the lower part of the very attractive console. This is a product of the C. R. Leutz Company, manufacturers of custom-built receivers. It is well designed and although it is too elaborate for many purposes and for many homes, it would appear to be the ideal unit for use where impressiveness or generally unusual results are desired.

Standard receivers embodying heavy-duty power amplifiers are manufactured by a number of other radio concerns, including the Howard, Kolster, Grigsby-Grunow (Majestic) and others, and the installation men will do well to investigate this field.

Radio for Your Car

(*Continued from page* 812)

control dial of the receiver which is tuned by means of a long extension shaft with a universal joint at each end.

It might be well to mention that the switch should be of the lock type, in order to prevent the radio being turned on by unauthorized persons when the car is in the garage or parked somewhere, thus running down the battery to such an extent that difficulty would be had in using the starter.

In addition to compactness, the receiver must fulfill other requirements. Garage men often wash cars without stopping to close the cowl ventilators. The full stream from a garden hose, descending through this ventilator, will not improve any chassis. The receiver must therefore be watertight, although well ventilated, for unventilated heater-type tubes are as much of a liability as the water. Even with these precautions the radio will still be exposed to extremes of heat, moisture and vibration. The materials going into the set must be specially selected so as to be rust-proof and sturdy. Insulation must not be damaged by heat. The assembly must be riveted instead of bolted, to prevent loosening from vibration.

This care should be extended to the leads also. These should preferably be enclosed in conduit to protect them from water, corrosion and abuse. Watertight fittings should be used wherever the leads emerge from the conduit. Fittings of this type have been used on boats for many years and are readily obtainable.

The B and C batteries are mounted in a steel box under the floor at the rear of the car. They do not need to be ventilated, but they must be protected and accessible. It should not require a major operation to change the batteries. The battery box should not have a "one-man top," in other words.

The addition of an antenna will complete the radio-frequency system. Some of the new cars now on the market have an antenna already installed. In this case it is only necessary to connect the lead to the set. In most cases it will be necessary to install one. Loop antennæ are unsuitable for use in cars because of their directional effect. It is hardly desirable to have the signals fade out or in every time the car turns a corner. A loop is also a cumbersome thing to install in such a constricted space. As a matter of fact, it would seem that there is only one practical place where the antenna can be put, namely, in the roof of the car. If the wires are above the roof of the car, they will be unsightly, whereas, if they are within the car they will take up valuable space.

Experience has shown that the best all-around antenna is a piece of copper mosquito netting tacked to the roof of the car. To install it, remove the cloth from the ceiling of the car and tack the mesh directly to the wooden frame. The cloth should then be replaced. A concealed lead-in wire can be brought down one of the door posts near the set.

The last item is the loud speaker. This presents something of a problem because of the peculiar acoustics inside a car. It is fortunate that no great volume is necessary, because of the limited space. For best results the speaker should be matched to the car. The large upholstered

surface inside the car absorbs much more of the high frequencies than of the low. The bass notes are still further reinforced by resonance within the small space. If a good dynamic speaker is used, this effect will be very noticeable. The result is similar to that sometimes noticed in a parade when the bass drums are close at hand and the high-pitched wind instruments are distant and faint.

To remedy this deficiency it is necessary to use a very poor loud speaker, one that has very little response to bass notes and pronounced resonance at higher frequencies. Such a speaker nominally sounds shrill and tinny, but when mounted in a car it will sound better than a good loud speaker. It is the old story of "Jack Spratt and his wife."

The best method is probably to try as many speakers of the 1924 variety as possible and to select the one that sounds the poorest on a good set in a large room. It will undoubtedly sound better than any of the others when tried in the car. In case no speakers are available, the problem may be approached more scientifically. Exponential horns, when they are very long, respond equally to all frequencies from high to low. The lowest note to which full volume is given has a wavelength equal to four times the diameter of the mouth of the horn. Below this critical point on the frequency scale the response falls off abruptly. As the horn is made shorter, this response will fall off more and more gradually. Thus by picking the proper length of horn, and the proper diameter at the mouth, the acoustics can be quite exactly matched.

As to the location of the horn, it will probably have to be placed wherever there is enough room. The best place, acoustically, is undoubtedly over the windshield. An exponential horn about twelve inches long and about four inches in diameter at the bell will fit into this space and give good results. A good magnetic speaker unit should be used to energize it. The little die-cast speaker shown in one of the illustrations is so designed that it may be mounted behind an opening cut into the dashboard of a coupé, where rear seat acoustics need not be considered.

Automobile radio sounds very complicated and difficult, but the problems are actually no greater than those which occur in any other good installation. It is our unfamiliarity with the special problems involved which makes them seem so difficult. Soon radios will be as common as traffic cops, and the traveling salesman, home from a trip, will proudly relate how he received WJZ on the Newburyport Turnpike, instead of going into a huddle in the corner with a new story from the backwoods.

A Modern Music Box

(*Continued from page* 809)

still further, the qualities of viola, violin and flute are closely approximated, Toward the upper end of the scale the Theremin can, with an amazing versimilitude, represent the soprano human voice, humming.

The Cleveland Orchestra demonstrated the possibilities of the Theremin in a concert given on December 4th, 1929, in Carnegie Hall, New York City. The audience exhibited its approval in repeated ovations and applause. When Rudolph Ganz, the noted pianist, heard the Theremin for the first time, he said: "The striking feature for me is that it is the first time that music has been extracted from something instead of being put into something, and that there is nothing between the human being and the music itself—no wood, no steel, no string, no horsehair—and that the personality of the performer is more sensitively presented than on any existing instrument."

An instrument so simple to play, and possessing such remarkable qualities of tone and pitch, will undoubtedly have a strong popular appeal. Those who never studied music, or who for one reason or another abandoned their study, will hail an instrument of this kind with delight. Where all the mechanical work is done by electricity, personal variations of expression will have an almost unlimited field in which to express themselves.

The Experimenter

(*Continued from page* 844)

night on the loud speaker," points out Charles Golenpaul, radio sales executive of the Clarostat Manufacturing Company, "and the reasons in favor of using telephone receivers for nighttime DX are both technical and ethical. It is much easier to tune for the elusive distant station with the ph ones clamped to the ears than by listening to the loud speaker. Also, the speaker, in the wee hours of the morning, is rarely listened to with a friendly ear by one's neighbors, to say nothing of one's immediate family.

"Unfortunately, very few modern receivers provide a jack for plugging in phones on a lower stage of amplification. However, it is a very simple matter to tone down the output, generally connected to the speaker, to headphone volume, by means of a variable resistor shunted across the receiver. The resistor should have a range of from practically zero to 500,000 ohms. The table model volume control Clarostat is ideal for this purpose, and can be connected by anyone in a few seconds. It is merely a matter of connecting the telephone receivers and the Clarostat in place of the speaker, and adjusting until the desired comfortable headphone volume is secured.

Junior Radio Guild

(*Continued from page* 839)

the kind used here, resulting in short, direct leads.

All connections of wire to apparatus should be soldered. Where it is necessary to make the connection to terminals on the apparatus, above the base, then the small holes should be drilled in the base to allow passage of the wire through from bottom to top.

Operation

The tuner may be operated, receiving signals satisfactorily, but of course with much less volume than if an audio amplifier were connected to it. A pair of phones may be connected to the two output posts which, temporarily, may be two half-inch round-head screws mounted on the sub-base until such time as the audio channel is added.

To operate the receiver, 135 volts of "B" battery are required in addition to a 6-volt storage battery, an antenna and a ground.

It will be found that the two dials track rather closely; that is, for a given station they will read very nearly the same dial numbers. To tune in a station the procedure is as follows: First turn the regenerative control, C3, so that the plates are completely meshed, producing strong regeneration; then, when the two tuning controls for C1 and C2 are rotated together a squeal will be heard at that point where a station is to be tuned in. When the loudest squeal is obtained, by careful adjustment of both the tuning dials the regeneration controls may be retarded until the squeal vanishes and only the clean, undistorted signal remains.

Next month will be described the three-stage audio-frequency amplifier which, when added to the tuner described here, will allow reception of signals with a loud speaker.

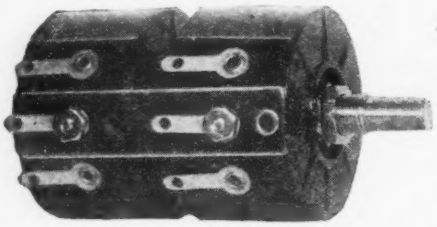
Parts List

2 Hammarlund coils, type SGT-17, T1, T2
2 Hammarlund chokes, type RFC-85, L1, L2
1 Hammarlund Jr. midget, type MC-23, 100 mmfd., C3
2 Lynch single resistor mountings
1 Lynch Veritas fixed resistor, 10,000 ohms, R1
1 Lynch Veritas fixed resistor, 3 meg-ohms, R5
2 Eby underpanel sockets, type 222
1 Eby underpanel socket, type 112A
2 XL binding posts (antenna-ground)
2 National SG grid grips
2 National equicycle variable condensers, .00035 mfd., C1, C2
2 National dials, type E
2 Pilot brackets
1 Yaxley 7-wire connector cable, 660
2 Yaxley center-tapped resistors, type 820-C, 20 ohms, R2, R3
1 Yaxley resistor, type 804, 4 ohms, R4
1 Clarostat volume control and switch (combination), 50,000 ohms, R6
1 Muter grid condenser, .00025 mfd., C4
2 Muter filter condensers, .5 mfd., C5, C6
1 18 x 7-inch panel
1 17 x 9-inch panel
2 boxes Cornish solid braidite

News from the Manufacturers

(*Continued from page 842*)

wherein the regular Philco dynamic speaker with its ten-inch cone is mounted in the floor of the console, pointing downward, thus giving what is called "indirect sound radiation."



Dual resistance unit

Clarostat Duo Type Volume Control

In meeting the requirements of radio assemblies calling for instantaneous control of two circuits, the Clarostat Mfg. Company announces the duo type wire-wound volume control clarostat. This device is made up of two standard volume control units with tapered windings, if so desired, to match any resistance curve. The units are mounted in tandem so as to operate with single knob, and the resistance units may be arranged for any resistance and may be electrically insulated from each other. A power switch can also be included in the assembly, so as to turn the power on or off by the means of a single volume control knob. Due to the unique winding and contact member of the volume control clarostat, the knob of the duo type turns with smooth, velvety action, and without noise even in the most critical radio circuits.

International's Bulletin 7

From the International Resistance Company, 2006 Chestnut Street, Philadelphia, Pa., comes the announcement of a bulletin on a new "Precision Resistance-Coupled Amplifier and Associated Power Supply," by Joseph Morgan of the engineering staff of the above company. Mr. Morgan in this bulletin discusses briefly the requirements of an excellent present-day audio amplifier, followed by the constructional data for a new resistance-coupled circuit, with accompanying circuit drawings and parts layout, as well as a frequency characteristic graph of a four-stage straight resistance-coupled amplifier.

An Improved CeCo Tube

The engineering department of the CeCo Manufacturing Company announce a tube which they designate as the CeCo 227 to replace the N27, a high vacuum detector-amplifier tube. Its features include two mica spacing members, the upper one being much larger than usual, a grid built around two supporting bars, a real improvement over the single support, short cathode, shortened distance between glass stem to electrode, and longer glass stem.

The larger upper mica separator holds both cathode and grid in positions concentric to the plate, and yet permits expansion when the tube heats, without strain to cause warping. Fastened loosely to one end, its inertia has the effect of damping vibrations of the electrodes. This prevents any prolonged howl in a receiving circuit. Also it limits the distance through which the support wires can bend in case the tube receives a severe shock. The two pieces of mica work together to hold electrical characteristics to a higher degree of uniformity than any previously attained. The doubly supported grid also helps to maintain tube uniformity. The supports prevent movement of the grid in any direction. Special treatment of the grid stops electron emission, thus correcting a common cause of tone distortion.

The CeCo 227 tube operates with 2.5 volts applied to the heater. The cathode sleeve should have a negative bias from 7.5 to 9 volts with respect to the heater.

Art console by Victor

When used as an amplifier the grid bias should be 13.5 volts negative to the cathode, and the plate voltage 180 positive. In the detector position the tube will operate with the usual condenser and leak. Also, it will be satisfactory as a grid bias or power detector, with 200 volts on the plate and 16 volts negative grid.

New Addition of Victor's

Housed in a distinguished cabinet of unusual beauty, the latest addition to the Victor line is announced. The instrument, Victor-Radio-Electrola RE 75, now makes it possible to obtain Victor-Radio in four models. The cabinet employs special Oriental walnut as well as the finest American walnut matched veneers. Its door panels are in bas-relief and the speaker covering is of Bengalese damask, harmonizing in coloring and design with the cabinet. Luxurious leather-back record albums in rich colors are a feature.

ART combines with PRECISION ENGINEERING

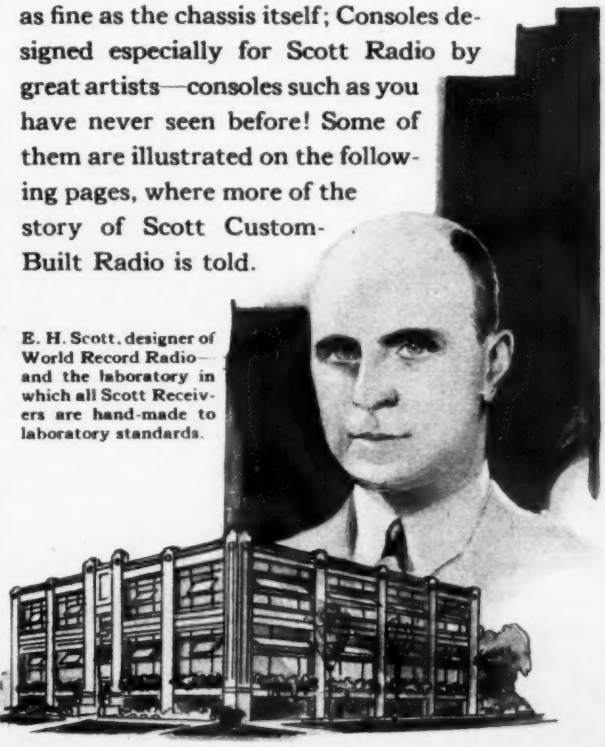
It to add laurels of magnificent dignity to those of world-record achievement now held by Scott

The Scott Custom-Built World Record Receiver is the *precision* instrument of radio. It is a hand-made product of the micrometer, the microscope, the oscillograph, other of the most infinitely accurate measuring and testing devices known to science, and of an inflexible determination that nothing short of ***absolute*** perfection in building can ever be productive of complete owner-satisfaction.

The physical and electrical dimensions and characteristics of every part and piece of wire *in each individual Scott receiver* are determined one by one—*not to a tolerance*—but to *exactness*, and made to match one another so perfectly that each completed Scott receiver will stand as a thoroughly qualified example of Scott precision, and as a symbol of the world record prowess which distinguishes Scott Custom-Built Radio from the ordinary.

Scott Custom-Built World's Record Radio has always been purchased for the sterling qualities of performance its precision engineering has made possible—Bare-nerve sensitivity! Seemingly unlimited power! Ability to bring in the greatest number of far distant stations! Superb, perfectly realistic tone! Positive selectivity! And for its absolute, unfailing dependability!

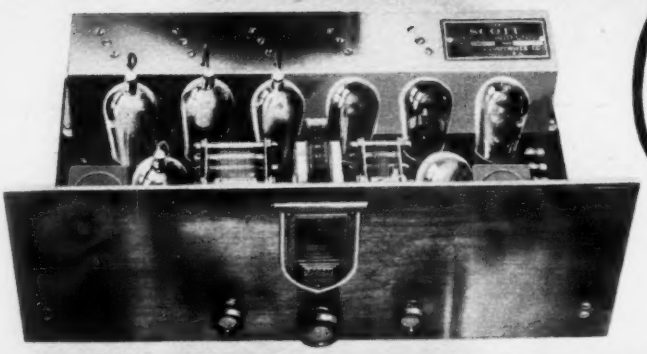
Now, however, Scott Custom-Built Radio is more than the perfect answer to the prayer of the radio-minded man. It is also the most beautifully clothed radio in the world. It comes in consoles as fine as the chassis itself; Consoles designed especially for Scott Radio by great artists—consoles such as you have never seen before! Some of them are illustrated on the following pages, where more of the story of Scott Custom-Built Radio is told.



E. H. Scott, designer of World Record Radio—and the laboratory in which all Scott Receivers are hand-made to laboratory standards.

SCOTT TRANSFORMER COMPANY

4450 RAVENSWOOD AVENUE .. CHICAGO, ILLINOIS



SCOTT CUSTOM

To bring in 117 programs consistently from 19 stations 6000 to 8000 miles away—all within a period of 13 weeks, is not an ordinary accomplishment. An ordinary receiver could not do it. A Scott Receiver, custom-built to Scott standards of engineering precision *did* do it, and Scott owners are constantly reporting equally remarkable reception.

The New Scott A-C SHIELD-GRID 10

This, we believe, is the most powerful broadcast receiver ever designed. It is considerably more powerful than the original Scott World Record Receiver. It brings in most of the distant stations with greater volume than can be used—even in the largest home, and reproduces *all* stations in a manner that is nothing short of *realism* itself.

The new Scott A-C Shield-Grid 10 is likewise perfectly selective. No station tunes at more than one point on the dial and local stations do not interfere, even to the slightest degree, with distant reception. Four Screen Grid tubes are used in this new Scott Model. Think of it! Four Screen Grid tubes! The resulting amplification is far, far greater than that obtained in any other receiver we know of. This means *sensitivity*, power and tone such as you have never experienced before. Everything worth listening to is within easy reach of the new Scott A-C Shield-Grid 10, and so it is in all truth that we say, "There is nothing else in radio like Scott Custom-Built Receivers."

Now, add to Scott precision, performance and dependability, the originality, beauty, richness, fineness and genuineness of Scott Consoles and the last vestige of argument as to which receiver to buy, is gloriously swept away.

Scott consoles are not mere cabinets of varied design. They are not merely things of wood, made to conceal a radio mechanism. Rather, they are studied creations, each designed to comply perfectly with a definite requirement of interior decoration. Nor are they made as ordinary consoles are made. Indeed not. They are hand-

The Cortez —an original, authentic, artistic reproduction of 16th Century Spanish furniture. It is impossible to conceive of a more beautiful piece. The price of this model complete is $703.

SCOTT TRANSFORMER COMPANY

here is nothing else in radio like BUILT RECEIVERS

made, like Scott Receivers, with just as much care and quality given to the unseen parts as to their fronts.

The five models illustrated on these two pages and the other shown on the next page are typical. The Cortez, shown at the left, is authentically Spanish. The romance and lavishness of the 16th Century Spanish Court is in every minute detail of its construction and finish. Its beautiful matched burls, its smooth, perfect inlays and carvings, its gorgeous hand-tooled leather panels and rich, genuine hand-wrought iron trim add to its fine construction to give the Cortez a proper place in a room suited to the introduction of a Spanish motif.

In sharp contrast to the Cortez, there is the Scott Moderne, illustrated at the right. This model is very nearly futuristic and will exactly suit the requirements of living room or den stressing the modern note.

A Model for Every Requirement

In between the Cortez and the Moderne there are more than a dozen other equally original Scott consoles. Some that portray the early English, French and German trends and others that can be described only by saying that there is nothing else in radio quite like them. Whatever your requirements are—whatever your taste may be, there is a Scott Console—a genuine, individual, original work of art, to completely and perfectly suit that requirement or taste.

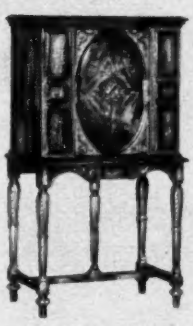
The next page contains a coupon which will bring you complete information and large photographs of all Scott Custom-Made Consoles. It also tells about another new Scott development—the final requisite of radio pleasure.

The Lancaster

The Lancaster, at the left, is another typical example of Scott cabinet artistry. The price complete is $345.

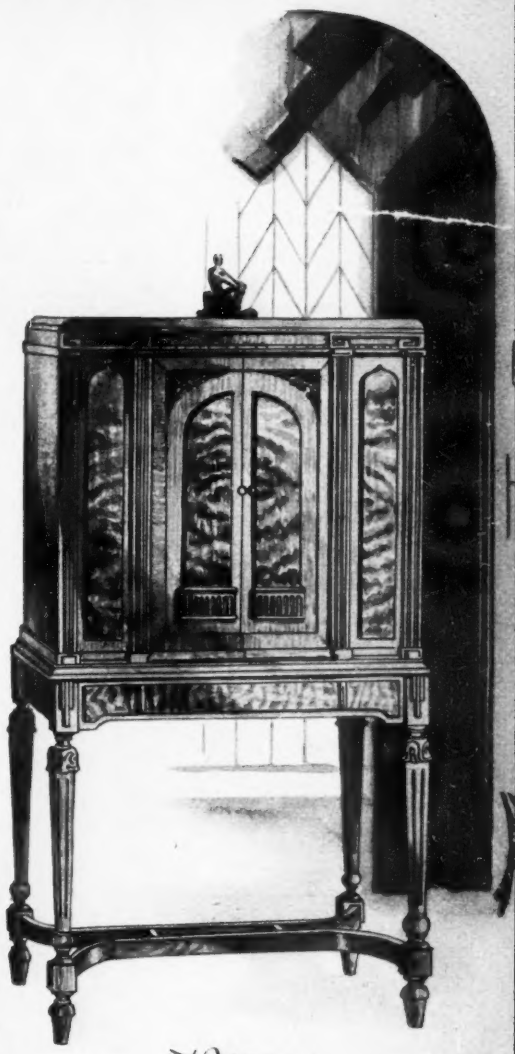
The Orleans

The Orleans, at the left, is a Jacobean Cabinet which successfully catches the rich stateliness and sublime dignity of the Renaissance period. The price complete is $353.



The Cavalier

The Cavalier, above, is authentically Puritan. The precious woods of which it is made, as well as its fine carvings, give the Cavalier an air of unusual distinction. The price complete is $334.



The Moderne

This is the Moderne, a true interpretation of the ultra-modern in fine furniture design. Note its severe straight lines, yet how these lines are relieved to graceful softness thru cleverness in the panelling. The Moderne complete is $351.

The Abbey

Above you see the Abbey, a glorified bit of Old English furniture work, thoroughly suggestive of the fine things which characterized the period it so faithfully represents. Massive carvings, deep design and sturdiness characterize the Scott Abbey. The price complete is $521.

Touch a Button —There's Your Station!

Only a thin cord connects the Scott Remote Control to the Scott Receiver. Yet what wonders go on inside this little cord. It carries the wish of the bridge-player, the bed-ridden, or the reader from his place of quiet to the Scott Receiver and causes the receiver to instantly reproduce the chosen program at the mere touch of a button. You have never experienced the delights of real remote control until you see this one in operation.

. . . and the new Scott REMOTE CONTROL

completes the perfection of Scott Radio pleasure

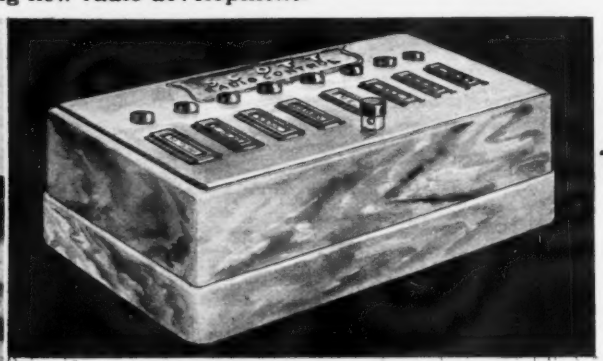
The world record performance and the outstanding beauty of Scott Custom-Built Radio are sufficient in themselves to decide anyone's preference for these fine receivers. But Scott also offers you perfected, practical, positive remote control!

Sit at leisure, any distance from your Scott Receiver, push the button for the station you choose—*and there* it is, *instantly!* Regulate the volume with a tiny knob on the control case. Switch from station to station by simply pushing buttons.

NOTHING ELSE LIKE IT

The Scott Remote Control actually does the tuning itself. The condensers in the receiver do not move when the control is being used. There are no motors, no relays, nothing in fact to get out of order or to become inaccurate. The cord connecting the Remote Control to the receiver is no thicker than a lamp cord. Nor does the Scott Remote Control interfere with the regular dial-tuning of the receiver. Either the dial or the Control may be operated at will by turning a switch one way or the other..

Clip the coupon and mail it now for full particulars of this truly amazing new radio development.



MAIL THIS COUPON NOW

RN3

SCOTT TRANSFORMER CO.,
4450 Ravenswood Ave., Chicago, Ill.

Send me full particulars of the new Scott A-C Shield-Grid 10, Scott Consoles, and Scott Remote Control.

Name .....

Street .....

Town ..... *State* .....

(EXCLUSIVE REPRESENTATIVE IN DETROIT—SCOTT RADIO SALON, 306 BOOK BUILDI

With the Manufacturers

(*Continued from page* 856)

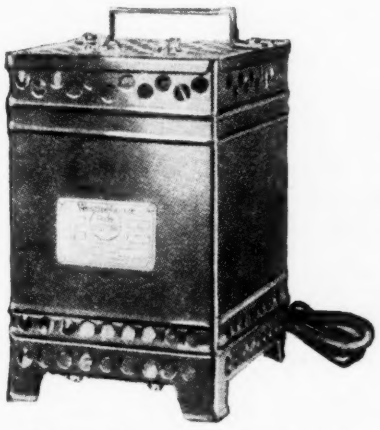
Filterette Manual

A new manual on "Radio Noises and Their Cure" is the announcement of the engineering staff of the Tobe Deutschmann Corporation, Canton, Mass. This manual, written in the question and answer style, for both the technical expert and the layman, describes the manner of interference elimination from the tiny sewing machine motor up to the giant-size commercial motors, as well as the troublesome sign flashers. A special type filter has been designed and is described in the manual for the farm lighting plant.

Westinghouse's New Battery Charger

A new Rectox rectifier for charging batteries by means of copper oxide rectification is announced by the Westinghouse Electric and Manufacturing Company. Employing the copper oxide principle, this charger presents a simple, safe and satisfactory means for charging storage batteries in all applications.

Being light in weight, this charger can easily be moved to the battery, eliminating the trouble usually encountered in moving heavy batteries. The leading feature of the Rectox charger is the fact that there are no parts to wear out or replace, with the exception of fuses which protect both the a.c. and d.c. circuits. No chemicals or acids are used, and there is no danger of explosion or corroding fumes.



Rectox heavy-duty dry charger

DeForest 422A Audion

With the requirements of a successful portable radio set as well as a rural radio set in mind, the DeForest engineering staff has developed a new dry-battery type of d.c. screen-grid tube. The DeForest Radio Company of Passaic, N. J. has just introduced this tube, which is known as the DeForest 422A audion.

This tube employs an oxide-coated filament of approximately three times the usual cross-sectional area. It has an emission averaging 50 milliamperes, with a passing mark of 25. The filament draws only 60 milliamperes at 3.3 volts. Other characteristics of the 422A audion are: plate voltage, 135; screen-grid voltage, 45; control grid, —3; mutual conductance, 465 micro-ohms.

IMPORTANT

to

Service-Men .... Radio Engineers Radio Technicians ... Repair Men Custom Set-Builders

WE are constantly being asked for names of competent radio technicians and service-men. A real shortage of such men exists, as servicing is still a great problem for most manufacturers.

We are, therefore, compiling a complete list of all the men the radio manufacturer can call upon whenever he needs help—help that you can give and be well paid for.

All you have to do is fill out the blank below, and return it to us so we can add your name and radio history to this list of experts. There is no charge made for this service, either to you or the radio manufacturer.

We merely want to give you an additional opportunity to make more money and gain more prominence in your chosen profession.

Just Fill Out and Mail to Service-man's Dept., Radio News, 381 Fourth Avenue, New York City

Name ..... Age.....

Address ..... City ..... State .....

Education: (Public School) ..... (High School) ..... (College) .....

(Technical School) ..... (Correspondence Course) .....

Do you have your own business? ..... Address .....

or By whom employed? ..... Address .....

How long have you been in the Radio Business? .....

What technical magazines do you read? .....

What type of radio business do you conduct? (please check)

Repair ..... Installation ..... Sales ..... Custom-built Sets .....

Do you make "public address" installations? ..... What make? .....

Do you recommend any particular make of custom built kit set to your clients? .....

What make? .....

Are you the accredited agent of any manufacturer for servicing and repair? .....

If so, whom? .....

What test equipment do you possess? .....

Does your radio business require all your time or are you employed elsewhere in some other profession? .....

If so, what? .....

Remarks: .....

Real Quality Reproduction

(*Continued from page* 799)

(b) to a negative maximum, and maintains this new potential until time (c) is reached. This reversed potential changes the direction of motion of the diaphragm; it now moves with constant speed from point (b)′ to point (c)′. And so on. It is evident that this flat-topped wave will be reproduced as a saw-toothed wave by the speaker. Naturally it will not sound the same. This raises havoc with speech sounds; with music it is not so important.

It is interesting to note, in passing, that the usual telephone transmitter and receiver are an excellent combination. The carbon grain transmitter is a variable resistor, its current output is proportional to the deflection. The receiver, though magnetic, has such a stiff diaphragm that the effects and music over the telephone sound like an ancient phonograph.

It has been assumed in the above that a true voltage amplifier was used, that is, one in which the output voltage has a constant ratio to the input voltage. Modern amplifiers do this only when their output is supplied to a constant impedance. When used as an amplifier, the vacuum tube may be considered as an alternating current generator whose internal resistance is equal to the plate impedance of the tube. Like any generator, the output voltage will drop when the load is increased, due to the potential drop in this internal resistance. When such a tube is used to drive a loud speaker, the load on it will depend on the load on the loud speaker, which in turn depends on the volume of the sound reproduced, the inertia and friction of the moving parts, and a number of acoustical effects, such as resonance in the cabinet. These variable loads give rise to a variable amplification ratio, which introduces more or less distortion. This effect can be greatly reduced by cutting down the internal resistance of the output tubes. By putting two tubes in parallel, the internal resistance is halved, with a consequent improvement in quality. This can be carried to absurd lengths; the author knows of one amplifier in which tubes with a total rating of nearly a kilowatt are employed to supply the two or three watts actually used. This has one other great advantage. The characteristic curve of a vacuum tube is not a straight line, but for a short portion of its length it is nearly so. When a vacuum tube is run at its maximum output, part of its operating range will lie on the curved portion of the characteristic curve. This will flatten the tops of the waves, and is one of the signs of emission. As the load on the tube approaches zero, the portion of the curve used will become smaller and smaller, until it is virtually a straight line. For this reason, also, it is good practice to use powerful tubes, such as –50's, even when the volume desired is small. Generally speaking, the more powerful the tubes used for a given output, the better the quality.

There is one other common source of distortion in audio amplifiers. All iron-core transformers introduce a third harmonic due to the variable permeability of the core. It can be made virtually constant by introducing an air gap in the core, but this reduces the impedance of the primary, with a consequent loss of the low notes.

Furthermore, an attempt to increase the primary impedance by increasing the number of turns will result in increased distributed capacity, with a consequent loss of the high notes. Nothing is left but to compromise, and in the best modern transformers this compromise has been very successful.

Transformers have one other failing: they introduce a second harmonic when their windings are carrying direct current. This can be avoided in either of two ways. By winding a transformer with a center-tapped primary, and coupling it in balanced push-pull, the d.c. components of the two tubes will buck and there will be no d.c. flux at all.

This method is almost always used in coupling the output of push-pull amplifiers to the loud speaker. It is seldom used for intermediate push-pull stages. For one thing, it is very difficult to build a satisfactory audio transformer with both primary and secondary in push-pull unless it is made very large. Furthermore, it is quite unnecessary. The push-pull arrangement automatically "bucks out" the second harmonic, so that it does not appear in the output. Of course, if the d.c. component is so large that the core is really saturated, it will reduce the impedance of the primary to the detriment of the low notes. This is very unlikely, however.

When the push-pull arrangement is not used the d.c. can be eliminated by using the scheme shown in Fig. 1. It will be observed that in this circuit the first tube is resistance-coupled to the primary of the transformer. The direct current is blocked by the condenser. As the "B" voltage is not impressed on the primary of the transformer, the primary and secondary may be connected in series, making it an auto-transformer, as in Fig. 2. This gives greater gain per stage, as 2:1 transformer becomes 3:1 with the windings in series. If the coupling condenser is chosen with the right value, it may be made resonant with the transformer primary at low frequencies in such a way that low notes which would otherwise be lost will be brought in full volume. The circuit has much to recommend it.

Of course the obvious way to get around these difficulties is to use straight resistance coupling, but its comparatively low gain usually requires an extra audio stage. The extra tube (or tubes) for this stage will usually introduce more distortion than a good transformer, so that little is gained. However, when screen-grid tubes are used as space-charge amplifiers, a gain of 60 per stage is quite feasible, so that we may see resistance-coupled amplifiers come back into favor, particularly since transformers are not satisfactory for coupling such tubes.

At the beginning of this article the discussion was limited to "perfect" loud speakers, microphones and amplifiers. It has been shown in the preceding paragraphs how amplifiers vary from the ideal,

(*Continued on page* 864)

but so far nothing has been said about commercial loud speakers.

The perfect loud speaker movement was assumed to have zero inertia, zero resistance and infinite stiffness and to be frequently floating in the magnetic field. The assumption of zero inertia is by no means true. In fact most of the amplifier output is used in overcoming this inertia. The general effect of this property is to make the diaphragm lag behind the current in such a way as to cause non-linear distortion. This is because there is not always sufficient power available to accelerate the cone. This condition can be improved by any scheme which will tend to make the back e.m.f induced in the voice coil equal to the impressed voltage. This can be done either by increasing the strength of the speaker's magnetic field, or by increasing the step-down ratio of the transformer supplying the voice coil. The first of these methods increases the induced voltage, the second reduces the applied voltage. Both schemes tend to make the two voltages equal, and both will reduce the volume if carried far enough, though the volume can be restored by using more powerful tubes, and, if necessary, two or more speakers. An arrangement such as this moves the diaphragm by brute force where it ought to go, rather than where it would be easiest for it to go. In general this will cause much higher stresses in the moving parts than would otherwise occur, and may cause rattles and blasting unless the apparatus is selected carefully. These limitations make such equipment impracticable for general use, although development along these lines may be expected in the future.

The operation of the loud speaker is also affected by the way it is mounted. If it is mounted in a small closed cabinet there may be very noticeable interference effects with resonance at certain frequencies. A large baffle of celotex or other similar material is a good mounting. As is well known, the shortest diameter of any such baffle should be at least one quarter the wave length of the lowest note to be reproduced. For the lowest notes in the audible range this requires a baffle nearly ten feet in diameter, which is somewhat awkward. One solution is, mount the speaker in a hole cut in a wall of the room. In case the landlord objects to this and the house has hot-air heating, a possible solution is to mount the speaker in one of the registers. Only the furnace must never be started. Some people still prefer small cabinets.

Magnetic phonograph pick-ups also have design defects which are more or less unavoidable. Referring to the cross-section drawing, it will be seen that the armature swings in an air gap, its action being very similar to the potentiometer circuit shown in Fig. 3. In such a potentiometer, the voltage between the slider and the center-tap will be proportional only so long as there is infinite resistance in the circuit a-b. In the equivalent electrical circuit of the pick-up, the permeability of the armature is so high in comparison to that of the air gap that the armature path is virtually a short circuit. This is very far from infinite resistance, and its effect is to introduce distortion of a non-linear character. For small amplitudes this distortion is negligible, but if

the armature approaches the pole pieces the distortion is very great. The solution of this problem is to make the air gap very long, the only limitation being the strength of the permanent magnet in the pick-up. If a dynamic field is used this limitation disappears. It is by no means improbable that dynamic pick-ups will appear on the best phonographs of the future.

The other great stumbling block in pick-up design is that of damping the armature. Some sort of damping is necessary to prevent resonance effects in the armature. This is purely a mechanical problem, but its solution effects the electrical output of the device. Damping is most commonly accomplished by small rubber blocks, but this is not altogether satisfactory. Rubber is poor enough for such a purpose even when it is new, but after it has hardened with age it is quite hopeless. The best pick-ups use oil damping which, though very satisfactory, is difficult and expensive.

Push-pull capacity pick-ups lack the first fault, but are under the same damping difficulties as the magnetic type. In general the electrostatic principle seems to be more satisfactory than the magnetic for both pick-ups and speakers. The practical difficulty at present is the high voltage required to charge them.

The only remaining subject for discussion is the detector. None of the usual devices for reducing distortion in vacuum tubes are effective here, since it is only by making the tube distort that it can be made to detect. The detector is primarily a simple rectifier, the various schemes of detection are improvements only in that they amplify as well as detect. It is the second harmonic introduced in the signal by the detector that causes the envelope of the radio-frequency wave to be impressed on the audio system. Unfortunately this same harmonic distorts the audio-frequency envelope as well. This distortion is a property of the vacuum tube; if the characteristic curve of the tube was composed of three straight lines instead of an S-curve, there would be detection without distortion. No such tubes are available. The problem rests with the tube designer.

Correct wave-form reproduction is probably the most difficult and the least discussed phase of the radio art, but imposing as the problems are, great strides have been made and there is great promise for the future.

How to Build a Beat Frequency Oscillator

(*Continued from page* 825)

adjustment of one oscillator will cause a correspondingly large variation in the resultant beat-frequency.

The April issue of RADIO NEWS will contain still more information about the many uses of this beat frequency oscillator.—THE EDITORS.

The attention of our readers is specially called to our editorial this month. The Editors will appreciate expressions of readers' views on this interesting subject.

How My Radio Helped Me Break the Transcontinental Air Record

(*Continued from page 797*)

airplane battery, and a ballast lamp in the set automatically protects the tubes against the average battery fluctuations. A seven-pound dynamotor, operating from a twelve-volt airplane battery, supplies the plate potential to the receiver. However, in my plane, I use a small wind-driven generator which provides both the 'A' and 'B' supply directly to the receiver. This was done to aid in the elimination of excess weight, as it was necessary for me to carry 550 gallons of gasoline, weighing nearly 7,000 pounds, on my transcontinental hops.

Radio now plays an important part in air navigation. The Department of Commerce has placed radio stations all the way across the continent for guidance of pilots by means of radio beacons. Every half-hour the beacon is shut off and weather reports are broadcast by voice on the same wavelength. In order absolutely to guarantee record time and to complete both non-stop hops successfully, it was necesary to have the best radio equipment installed in my ship.

On the morning of the twenty-eighth, as I took off with a heavy load for the West from Roosevelt Field to lower the previous record of twenty-four hours, I was receiving weather reports from Hadley Field assuring me of satisfactory flying conditions over the first hazardous part of the trip, the Allegheny Mountains. After passing over Altoona, I began to run into heavy ground fog which covered the entire surrounding country. This condition is confusing to any pilot, but with my radio I was able to receive favorable reports of the weather and I knew that the ground fog was only local.

The remainder of the day I was favored with splendid visibility. I did not need the radio; however, it was comforting to listen in every half-hour and be advised of general conditions throughout the United States. Upon arriving at Cajon Pass, the entrance of the transcontinental route into Los Angeles, an immense ground fog lay over the entire valley, giving me considerable concern as to the landing possibilities. It was about eight o'clock in the evening and darkness was rapidly coming upon me. Once again the radio came to my rescue, and informed me that the Los Angeles Metropolitan Airport was open, and that the fog had not yet reached that area.

On the return trip I was favored with good weather. But head winds, however, shortened my time record. The radio was used only as a comforter at the half-hour periods, but became valuable when I arrived over Columbus and nightfall came upon me once again. Clouds were rising rapidly to high altitudes, and it was necessary to fly blindly through them in my climb upward to get on the top. From Columbus on into New York there was nothing but a sea of clouds broken only at occasional points where I could see the lights of automobiles and towns through the holes. Without the use of radio I doubt if I should ever have continued, because the weather looked more

(*Continued on page 867*)

and more questionable as I kept speeding eastward, and it was out of the question to rely entirely upon my senses and unguided judgment alone. Here, again, the radio unquestionably was the greatest of help, and it made the flight a success. By its use, I was told the weather conditions and of the broken forecast over Roosevelt Field which would permit a safe landing, and I continued on through the darkness with the utmost confidence, arriving at Roosevelt Field in record time by some forty minutes.

I am keenly enthusiastic over the use of radio in aircraft. On one or two occasions I have flown a plane not equipped with radio on cross-country trips. Each time I felt as though there was something lacking. I missed the comforting half-hourly news from the Department of Commerce radio weather stations and the steady buzz of the radio beacon.

I always make it a point to fly over the airways as outlined by the Department of Commerce, because of their facilities to aid the pilot in air navigation.

Still another experience helped to prove the value of radio. Immediately after the National Air Tour I took off from Detroit for New York with very questionable weather ahead. With twelve other pilots I headed for New York. We went through several severe snowstorms with negligible visibility and I am certain that I should never have continued if it had not been for the radio beacon and encouraging weather reports from the eastern end. I made the flight from Detroit to New York in three hours, which I believe is record time, whereas the other pilots all turned back at Toledo, and not one of them came through. They did not have radios.

I believe that the time will come when there will be written in the air traffic regulations a special enactment calling for installation of radio on all aircraft. The aid which radio insures to air navigation is indispensable, and its use should be compulsory.

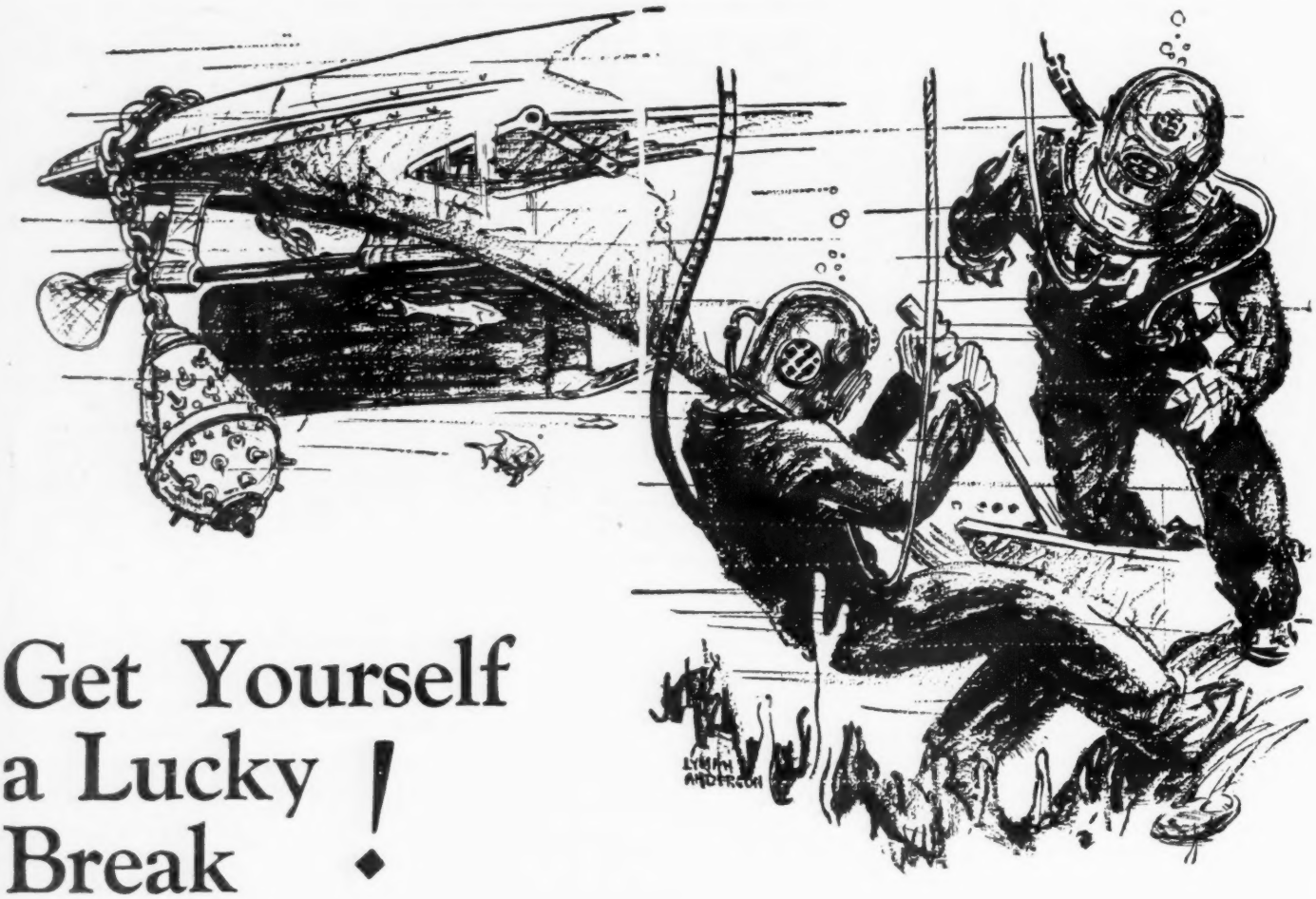
And Everywhere That Mary Went—the Mike Was Sure to Go

(*Continued from page* 796)

take-off on the transmission of the truck. Of course charging facilities include provision for the storage batteries used to supply filament power.

The power units employed in vehicular sound picture recording are quite large, because of the need for constancy under varying conditions. Storage batteries for filament supply are usually of the 100-150 ampere-hour size. The gasoline motor for a large location truck's d.c. and a.c. power supply may rate 10-20 h.p., the charging generator about 1 Kw., and the alternating current generator may be about 2 kva., even though the total of the ratings of the camera and recorder motors which it supplies is not over 0.5 kva. Such motors run about 1/20 horsepower for a camera motor and 1/10 horsepower for a recorder motor.

Plate and condenser transmitter polarizing voltages are derived from dry batteries, although sometimes a small motor generator set, properly filtered, is employed, and small storage batteries with a few ampere-hours capacity.



Get Yourself a Lucky Break!

DO you know that if an obscure young Dane, living in Switzerland, hadn't fallen in love with a Swiss girl, you might not have had the radio? Do you know that if a heat wave had not swept over the United States, Calvin Coolidge might not have been President? That a sudden downpour of rain in Belgium one hundred and fifteen years ago was a direct cause of the Great World War? That if Alexander the Great hadn't got drunk on a "wild party" in Babylon, there would have been no Roman Empire?

Do you know that it's a hundred million to one chance that you were born? That nine men out of ten meet their wives by pure luck?

The great leaders of the world recognize and respect luck. More than that, they know how to take advantage of a lucky break. Do you? Let us help you.

Now Brief Stories Will Show You How

IN the February issue of Brief Stories Magazine, we have created a department called "LUCKY BREAKS" in which the great and near-great tell just how luck came their way, and how they recognized and took advantage of it. Probably your lucky day is just around the corner. Will you recognize it, when it comes? Will you know what to do? Read "LUCKY BREAKS" in Brief Stories Magazine for March and be prepared. Invest a quarter in Brief Stories at your nearest newsstand, and you may lay the foundation for a million, two million, ten million—who knows how much? Maybe reading "LUCKY BREAKS" will be *your* Lucky Break.

"LUCKY BREAKS" Is Just One Department in the New Brief Stories

BRIEF STORIES MAGAZINE also brings you a dozen or more corking good stories of adventure in strange, far-off lands every month. Read "Loot of The Little Jade Men" in which an organized band of Chinese Pirates pit their ability against a white man. The battle of wits and strength that follows is an epic of craftiness. Read "The Attack on Zeebruge," an eye-witness' account of one of the most important naval exploits in the World War. Read "Chained to a King" wherein a courageous white man gambles between a horrible death and a fortune in black pearls. Get them all in the February issue of Brief Stories, and settle down to several enjoyable, inexpensive evenings of choice reading entertainment.

See How It's Done in MARCH

Brief Stories

NOW ON SALE AT ALL NEWSSTANDS—25c a Copy

A New Superheterodyne

(*Continued from page* 803)

between the primary and secondary of a tuned secondary transformer to get sufficient reflected impedance into the primary.

It is not possible to get all of the gain out of a transformer, when used between three-electrode tubes, because a condition of instability and a tendency for oscillation appear when the gain reaches a certain value per stage. The maximum gain would of course be reached with good shielding, by-passing of each stage to eliminate coupling by common impedance, and neutralizing. No purpose would be served by using a tuned primary and tuned secondary transformer for coupling three-electrode tubes, because all of the gain obtained by tuning only the secondary cannot be used even with perfect shielding and neutralization.

From these considerations it is evident why it has been standard practice, in designing transformers for coupling three-electrode tubes, to use the tuned secondary method.

The four-electrode shield-grid tube, however, has radically different properties from the three-electrode tube. The presence of a shield between the grid and the plate reduces the capacity between the grid and the plate. The shield does not materially change the input grid-to-filament capacity—on the other hand, the plate-to-filament capacity is considerably increased.

In such tubes the short-circuiting effect of the output capacity is several times the short-circuiting effect of the input capacity. Since tuning either the primary or the secondary of a transformer has the effect of removing either the output capacity or the input capacity respectively, the idea is immediately suggested to tune the primary.

The effect of the shield is to increase greatly the plate-to-filament resistance from a value of less than 20,000 ohms to a value in the order of 500,000 ohms. With the three-electrode tube it was not very difficult to get a primary impedance at least equal to the plate-to-filament resistance of the tube.

A tuned secondary transformer which was satisfactory for the three-electrode tube having a primary impedance of possibly 50,000 ohms would give very little gain when used with shield-grid tubes, because of the very small proportion of the total plate circuit impedance which the primary of the transformer would represent. A tuned primary would, however, have a very high impedance, and would make it possible to get a much larger proportion of the voltage generated in the tube across it. It is evident that if the primary impedance of the transformer was equal to the plate-to-filament resistance of the tube, only one-half of the voltage would appear across the primary. From these considerations it is easily seen that the primary of a transformer used with shield-grid tubes must be tuned.

In the case of the shield-grid tube the plate-to-filament resistance is so high that its effect upon the tuned primary in producing an equivalent series resistance is negligible. This means that there would be no loss in selectivity in tuning the primary, but a considerable increase in voltage amplification would be then effected.

After determining that the primary of the transformer must be tuned, there is left one remaining possibility, namely: tuning both the primary and secondary. Tuning the secondary would of course eliminate the short-circuiting effect of the input capacity of the tube. When both the primary and secondary are tuned, a maximum transfer of energy no longer takes place with close coupling. The condition for maximum transfer of energy is, to the contrary, a very loose coupling. Since space limitations eliminate the possibility of separating the primary and secondary by a space of six or more inches, depending upon the type of coil used, it was necessary to turn one of the coils so that it was practically at right angles to the other. It was found, however, that there is no such thing as perfect shielding. The gain which can be obtained with the tuned primary transformer is more than can be successfully used. The tuned primary transformer gave a gain of 75 per stage at a frequency of 475 kilocycles with complete copper shielding and by-passing. It was found, however, that this gain had to be reduced for stable operation. For this reason the tuned primary and secondary transformer was found to offer no advantages from a standpoint of the amount of amplification which could be used in the set, and it had the distinct disadvantage of an additional adjustment for each stage.

Intermediate Transformers

Utilizing a correctly designed type of solenoid coil in the intermediate amplifier transformers has produced a very high gain per stage. It was the natural supposition that with the tremendously high gain obtained it would not be practicable to use many stages of this type. Contrary to this belief, in the Lincoln de Luxe 10 five tuned intermediate stages are successfully used, building up a total i.f. amplification exceeding anything previously known to our experience.

Combined in this system, each stage is accurately tuned by a high-grade low-loss stator and rotor type condenser, tuning the plate circuit of the screen-grid tubes. The over-all of the five operative tuning units produces a high degree of rejectivity from the frequency desired.

In the Lincoln de Luxe 10 are employed a large size antenna coil, space wound, using No. 16 enameled wire, and a space-wound oscillator coil, both input and oscillator being tuned by .0005 mfd. variable condensers, allowing a register below 200 meters and up to 550 meters.

Tubes employed are a type –27, in the oscillator; a –24, first detector; four –24's in the intermediates; a –27 as a second detector; a –27 in the first audio and two –45's for push-pull or second audio stage.

In the chassis is incorporated an efficient filament and heater supply transformer having a safety factor of 100% overload. The sub-base is composed of genuine bakelite supported by a rigid hardwood frame.

The performance of the Lincoln de Luxe 10 has far exceeded the furthest

(*Continued on page* 870)

expectations of the designers. On a preliminary test of the first model finished, made at Oak Park, Ill., eight miles from the center of Chicago, and in the center of the ring of all Chicago's broadcasting stations, twenty-five outside stations were played at 12:30 o'clock noon. Stations such as KTHS, Hot Springs, Ark.; Davenport; Kansas City; Birmingham, Ala.; Shreveport, La.; Schenectady, N. Y.; Ft. Worth, Texas; Minneapolis, Minn.; Denver, Colo., and others were played with heavy volume, although the noise level was susceptible on many of them. On repeated tests made at the same location, starting at 55 kc., every channel was played to 1500 kc.—the high amplification allowing every channel to be brought in clear and loud without the customary atmospheric noise so common in distant reception.

Stations 10 kc. on each side of all local stations were played with ease without interference from powerful local stations. The quietness of the distant reception was uncanny, and even the musical renditions from west coast stations were as clear as those received from local stations.

The extreme selectivity in the Lincoln de Luxe 10 does not impair the register of complete musical frequencies, and with the aid of the very high grade type of audio transformers used, excellent tonal qualities are available.

The Lincoln de Luxe 10 has an auxiliary plate supply, furnishing accurate voltages for the receiver, as well as 150 volts of 60 mils capacity for the excitation of the dynamic speaker field.

The consistent performance of this new receiver has entirely revolutionized the designers' ideas of the possibility of radio reception. The high noise level in the past has made this distant reception very undesirable to listen to, and the high amplification in the Lincoln de Luxe 10, with stability to tune below the noise level and, at the same time, its extreme selectivity which allows every channel to register, has come closer to producing the ideal receiver.

Racket Suppression

(*Continued from page* 829)

line. Slight buzz like corona. Wet weather. No ground wires on pole.

3. Pole on Perkinsville feeder line. Same as No. 2. Same as No. 2.

4. Perkinsville station Buzz on H. T. line. Check in station. This station only runs when water is high. The operator's house is lighted from a small transformer in the station. The 2300 volt side of this transformer is quiet. The load side has a buzz which stops when the house line is opened close to the transformer. The buzz may be again picked up on the house line with the transformer secondary either connected or not. Line is about 400 ft. long. Radio in his house is nearly impossible except in damp weather or for short times. The noise is the same whether his station is running or not. It can be picked up only on the high secondary or on lines paralleling or close to this secondary line. The exciter is ungrounded and makes some noise.

Hum Control

(*Continued from page* 814)

It is also to be noted that the resistance, as connected across the filter output, causes a loss of the rectified and filtered current, which performs no other really useful function than to generate unwanted heat. It may be argued that if all of the receiver tubes except the rectifier be removed, the filter condensers will be subjected to higher voltages, which this resistance helps to hold down by its loading effect. While this argument may have some validity for separate "B-C" eliminators, in my opinion it has no validity in present-day receiver designs, inasmuch as intelligent users will not operate their receivers with all the tubes removed, especially if instructed not to do so. Furthermore, unless the wasted current in this resistance is a very considerable portion of the total filter load current, its effectiveness as a voltage limiter may be small; and if the filter condensers have an otherwise satisfactory voltage rating they will certainly withstand any temporary rise of voltage caused by the removal of one or more, or even all, of the receiver tubes. As we all know, these condensers are factory-tested at voltages many times their rated voltage for continuous service.

The manner in which the ripple varies with the load current of a simple condenser type of filter, for varying capacities, is shown graphically in Fig. 2. The circuit diagram indicates the test arrangement. By means of resistors R and R1, the load current was varied at a constant load voltage of 250 volts through the usual range up to 70 milliamperes. Curves 1, 2, 3 and 4 indicate the variations of a.c. ripple in volts present across the load. with 1, 2, 4 and 8 microfarads of condenser, respectively. It is seen that, with any given amount of condenser, the ripple voltage varies directly with the load current. The familiar law of diminishing returns noticed by most engineers engaged on filter designs is here clearly shown. With one microfarad in circuit, the addition of another causes about a 50% decrease in ripple, while the addition of three more only reduces it to about 25%, and the addition of seven more only reduces it to about 10%. These graphs make clear that all unnecessary loads on the filter should be dispensed with. Doubling the load, for example, requires double the amount of filter apparatus for the same ripple magnitude.

A generally used arrangement is shown in Fig. 3. Here R is the plate voltage divider, R1 is the power tube grid bias resistor, and R2 is the bias resistor for first audio and all radio tubes. To prevent circuit complication the coupling devices have been omitted from this diagram. While greatly reducing the possibility of interstage couplings, this arrangement still has most of the disadvantages of the preceding system. A much better circuit arrangement is shown in Fig. 4. Here a series filter arrangement is shown which provides one stage of filtering for the power tube, two stages for the first audio and all radio tubes, and three stages for the detector tube.

The Boy Scout Four

(*Continued from page* 790)

by turning up or down the small screw in the neutralizing capacity, C3, until, when the dial of C1 is rotated over a small arc, a squeal is heard having two peaks of equal intensity with a silent space in between. To do this it may be necessary to make the adjustment with a piece of wood whittled to resemble a screwdriver blade, since touching the condenser with a metal screwdriver will throw it out of adjustment. It may take several tries to make this adjustment correctly.

In tuning in stations, the two main tuning dials should be adjusted together. That is, beginning at the lower end of the dial, the r.f. dial (C1) should be set at 5 while the detector dial (C2) should be rotated over a small arc at 5. Then, in easy jumps the position of the dial of C1 should be shifted, repeating the process of tuning over a small arc with the dial of C2 at each new position. As the dial of C2 is rotated a squeal will be heard at the point where a station is to be tuned in. If it is difficult to make the receiver squeal, then it will be found necessary to turn up the regeneration control a bit. Once a station is tuned in, the regeneration control may be retarded to take out the squeal.

After a number of stations have been received and their dial position noted, a chart or curve may be prepared on cross-section paper, the dial positions being numbered along the bottom or horizontal edge of the paper, the wavelengths numbered along the left-hand or vertical edge. After several station positions have been plotted, a line may be drawn joining these points so as to result in a "curve." From this curve the dial positions of other stations not yet received may be ascertained.

Parts List

1 Gen-Win coil kit (radio-frequency coil No. 401 and three-circuit tuner No. 402) (T1, T2)
2 USL "Lafayette" condensers, .0005 mfd. (C1, C2)
4 Pilot UX sockets (V1, V2, V3, V4)
2 Pilot audio-frequency transformers, No. 391, 3½ to 1 (T3, T4)
1 Pilot output transformer, No. 394 (T5)
1 Electrad tonatrol (with switch), type AS (R1)
4 Carter filament resistors (4 ohms), RU4 (R2, R3, R4, R5)
2 General Radio dials (4")
1 Hammarlund equalizing condenser, 40 mmfd. (C3)
1 Sangamo condenser, .001 mfd. (C5)
1 Sangamo fixed condenser (with grid leak clips), .00025 mfd. (C4)
1 Durham grid leak, 3 to 5 megohms (R6)
1 panel, 7 x 18 inches
1 baseboard, 9 x 17 x ¾ inches
1 coil (25 ft.) insulated hook-up wire
1 binding post strip with binding posts

In constructing the receiver described here it is quite permissible to substitute other parts for those listed above, *providing* the physical dimensions of the substituted parts are not materially different from those illustrated. In making the substitution care must be exercised in marking off the mounting holes, which in some cases may differ from those shown in the panel layout of Fig. 2.

Building the Loftin-White Amplifier

(*Continued from page* 802)

system is particularly well adapted for passing onward a large percentage of the high amplification of high amplification tubes. Other than the advantage of the extraordinarily good frequency characteristic we see no particular appeal in the system for the very low mu tubes that prevailed up to several years ago.

Our series of articles will bring out the manner in which we utilize these high resistances with high mu tubes in direct-coupled systems, to obtain an extremely wide variety of results, thus making the system one of great flexibility covering almost any uses that might be contemplated.

Coil Design

(*Continued from page* 831)

downward-sloping illustration line, indicating a coil 2¾ inches long wound with 35-turns-per-inch wire, cuts scale No. 8 at 96. The exact number of turns is 96.25, thus showing the scale to be quite accurate enough for any case in which the chart would be used.

There will be few calls, in all probability, for points corresponding to numbers greater than 100 on scale No. 8, but for completeness' sake and for possible future needs, the 110, 120, 130, — 200 points may be located by using point 2 on No. 4 and appropriate points on No. 6. For the 5, 6, 7, 8 and 9 positions on No. 8 we may joint ½ on No. 4 with 10, 12, 14, 16 and 18 on No. 6. It is little use going below 5 on No. 8, as the chart is not accurate for such short coils.

Caution—Do not rely on the point marked ¼ on scale No. 4. It is out of place, its proper position being about ⅛ inch higher up on the line.

If you decide to ink your work in—and this is a very good plan—draw two faint lines to the right of No. 8 and parallel to it, at distances of $\frac{1}{16}$ and $\frac{3}{32}$ inches respectively. Prolong the marks representing the numbers 5, 6, 7, 8, 9, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100, 150 and 200 to the $\frac{3}{32}$ inch line, and the smaller divisions to the $\frac{1}{16}$ inch line. Put numbers opposite the long lines only.

While you are doing this, it will be a good plan to make a further slight addition which will facilitate the use of the chart. Divide the Index Line (No. 5) into equal sections (points ⅛ of an inch apart will do nicely) and number them consecutively—whether up or down is quite immaterial. If you do this, you will save marking up the chart with pencil every time you use it.

To illustrate by the broken lines printed on the chart: instead of actually drawing the line from 250 on scale No. 3 to 2 on No. 7, simply read the intersection of the straight-edge with the Index Line. Suppose it is 21.9. Then swing the straight-edge to 35 on No. 6, check that it passes through 21.9 on the Index Line, and read off 96 turns on No. 8, and 2¾ inches on No. 4.

Index to Advertisers

(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

A Broadcaster's Dilemma

(*Continued from page 793*)

pressed air forced in at this opening would soon dry them out. Eight of these sturdy units were shipped out to KNX and a local steel company sent over a crew of men to install them.

The results of the change were gratifying. Not only did testimonials indicate that local listeners were getting better service, but measurements showed that field distribution much more nearly approached the ideal circular form. A large, densely populated area of Los Angeles and its extensive environs was thus, in effect, moved a number of miles closer to the transmitting station.

The work of broadcasting bigger, better and brighter bedtime stories once more went on apace.

On Short Waves

(*Continued from page 848*)

KOVNO (Lithuania). Station RYK. Frequency—155 kc. Power 7 kw. Approximate distance from New York—1935 miles.

Announcement—First of the emission disc, then the words "Hello, hello. Lithuanian Radio Kaounass." At the end of the period, the national Lithuanian hymn.

I would also like to call your attention to the fact that we have received letters from amateurs saying they have heard our station as far away as California, so I should like to ask you if it is possible to let me know the results of listening to the Lithuanian post in America.

Thanking you in advance.

Ing. A. Stankevitch, Radio Stotis, Kaunas. Lithuania.

Auto Radio Receiver Design

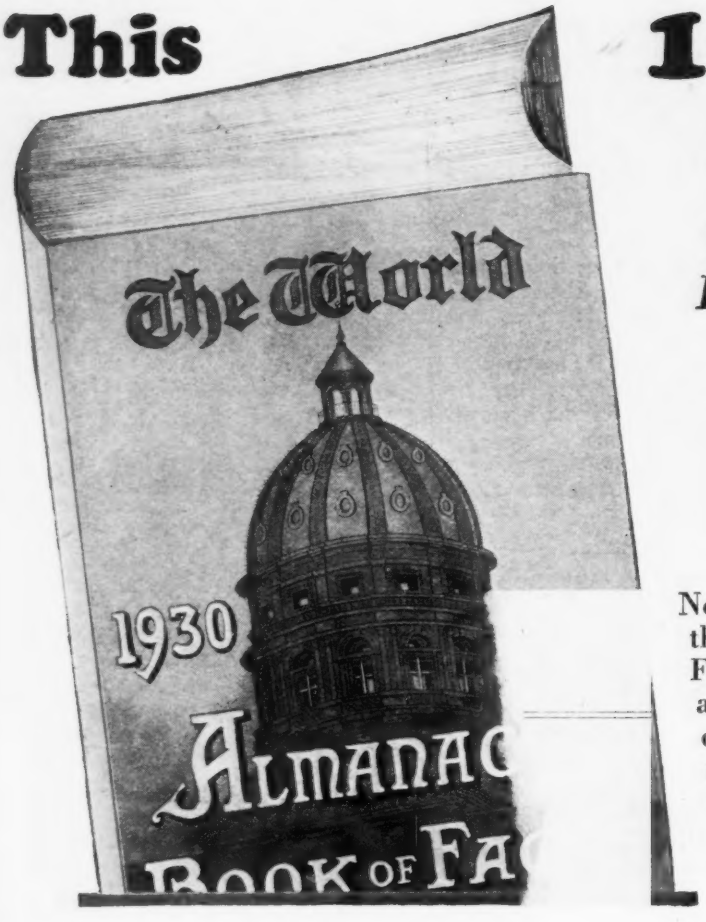
(*Continued from page 832*)

stages of radio-frequency amplification, a normal signal is fully able to overload the detector. Therefore we chose power detection, since its loss of sensitivity is amply made up by the additional gain of the radio-frequency stages.

In the factory an inexperienced employee was able to assemble the kit in one-half hour, and wired the set in one hour. The set has been designed so that it can be mounted anywhere in the car where a space six inches square and seventeen inches long is available. The tuning is accomplished by a gear arrangement mounted on the condenser shaft, and operated by a long, steel-clad, flexible extension coupling. In the complete kit a control box is furnished which mounts directly under the steering wheel so that tuning, variation of volume and filament control can be managed from the driver's seat. The set itself is inclosed in a black crystalline-finished steel box, and can be mounted under the floor board, behind the dash, under the seat, or in any other place which might be available. All leads to and from the set are shielded.

In a future article complete specifications, diagrams and lay-outs will give all the details necessary for anyone to build a very fine, economical and reliable automobile receiver.

This 1000-PAGE VOLUME



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